Offshore Northern British Columbia Herring Survey, August 2004

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V9T 6N7

2005

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2713

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OFFSHORE NORTHERN BRITISH COLUMBIA HERRING SURVEY, AUGUST 2004

by

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Cat. No. Fs 97-4/2713E ISSN 0706-6473

Correct citation for this publication:

Thompson, M., Daniel, K., and Therriault, T.W. 2005. Offshore northern British Columbia herring survey, August 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2713: vi + 42 p.

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ABSTRACT

Thompson, M., Daniel, K., and Therriault, T.W. 2005. Offshore northern British Columbia herring survey, August 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2713: vi + 42 p.

We conducted a 14 day summer, hydroacoustic and mid-water trawl survey in offshore waters of northern British Columbia for Pacific herring (*Clupea pallasi*). The area surveyed included Queen Charlotte Sound, Hecate Strait, Dixon Entrance and the west coast of the Queen Charlotte Islands. This survey was designed to provide a pre-season recruitment strength prediction based on the proportion of pre-recruit herring (age-2+) encountered in offshore waters six months prior to the commercial roe fishery. Although still in the developmental stages, we believe this survey has potential application to the three northern British Columbia herring stocks: Queen Charlotte Islands (QCI), Prince Rupert District (PRD) and Central Coast (CC). Characterization of offshore herring distributions provides important information on the spatial distribution of northern herring and their role in a northern ecosystem, specifically potential locations for summer feeding grounds. In addition to length and weight data, we collected scale samples for aging, DNA samples for mixed stock identification, and stomach samples to characterize offshore feeding. The non-selective nature of mid-water trawl gear allowed characterization of fish assemblages, including information on herring predators. Herring aggregations were identified using an on-board, dual-beam Simrad EK500 hydroacoustics system operating at 38 and 120 kHz prior to fishing. We used CTD casts to provide information on general oceanographical conditions encountered during the survey including, temperature, salinity, transmissivity, and fluorescence.

RESUME

Thompson, M., Daniel, K., and Therriault, T.W. 2005. Offshore northern British Columbia herring survey, August 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2713: vi + 42 p.

Nous avons effectué un relevé à l'aide d'une sonde hydroacoustique et d'un chalut pélagique au large de la Colombie-Britannique pour évaluer la population de harengs du Pacifique (*Clupea pallasi*). Le secteur étudié comprenait la baie de la Reine-Charlotte, le détroit d'Hécate, l'entrée Dixon et la côte ouest des îles de la Reine-Charlotte. Ce relevé a été conçu de manière à pouvoir utiliser les effectifs de harengs de pré-recrue (ayant au moins 2 ans) rencontrés au large six mois avant l'ouverture de la pêche des harengs rogués pour estimer le recrutement avant la saison. Bien que le relevé n'en soit encore qu'au stade du développement, nous pensons qu'il pourra s'appliquer aux trois stocks de harengs du Nord de la Colombie-Britannique : celui des îles de la Reine-Charlotte (IRC), celui du district de Prince Rupert (DPR) et celui de la côte centrale (CC). La caractérisation de la distribution des harengs au large de la Colombie-Britannique permet d'obtenir des informations importantes sur la distribution spatiale des harengs du Nord, en particulier les emplacements possibles des zones où les poissons se nourrissent en été, et sur le rôle que jouent ses poissons dans l'écosystème marin nordique. En plus des données sur la longueur et le poids des poissons, nous avons recueilli des échantillons d'écailles pour déterminer l'âge des poissons, des échantillons d'ADN pour l'identification des stocks mixtes et des échantillons stomacaux pour déterminer le régime des poissons au large. La nature non sélective du chalut pélagique a permis d'identifier plusieurs assemblages de poissons et d'obtenir notamment des informations sur les prédateurs des harengs. Les agrégations de harengs ont été repérées avant la pêche grâce au systèmes de détection hydroacoustique à doubles faisceaux Simrad EK500 monté à bord du bateau et opérant à 38 et 120 kHz. Nous avons utilisé les profils de CTD pour déterminer les conditions océanographiques générales qui dominaient durant le relevé et notamment la température, la salinité, la transmissivité et la fluorescence.

INTRODUCTION

Reduced biomass for some northern Pacific herring (*Clupea pallasi*) stocks (Figure 1) has renewed interest in the accuracy of recruitment forecasting procedures. In general, British Columbia herring mature, spawn, and recruit (join the adult stock for the first time) at age-3 (Hay and McCarter 1999). Currently, each of the five major British Columbia herring stocks is assessed annually. This stock assessment procedure uses an age-structured model to forecast returning spawner biomass and adds an average, historically observed recruitment to account for newly recruiting fish (Schweigert 2002). Given that interannual variability in recruitment can be substantial, a forecast of recruitment strength would be extremely valuable for managers. Independent offshore surveys conducted in late spring or summer could dramatically refine recruitment forecasts for northern herring stocks (Therriault 2003). This refinement is essential to "fine-tune" harvest levels, especially when stocks are near the pre-defined fishery cut-off level.

Information on the distribution of pre-recruit and adult herring in offshore waters during the summer feeding months is limited, as is information about their basic biology and role in a northern marine ecosystem. In addition to developing the capability for recruitment strength predictions for northern stocks, the survey addresses the role of herring in a northern ecosystem, and the extent to which ecosystem factors affect herring distribution, abundance and growth.

SAMPLING METHODS

The hydroacoustic and mid-water trawl survey was conducted over a two week period between August 3 and 16, 2004 aboard the CCGS *W.E.Ricker*, a 58 m stern trawler. Thirty-one mid-water trawls were performed between Goose Island Bank in the south and Dundas Island in the north, with a circumnavigation of the Queen Charlotte Islands (Table 1). The survey followed both pre-determined acoustic lines, a criss-cross pattern of the 91.4 m (50 fathom) contour, moving from deeper water (182.9 m or100 fathoms) to shallower water (54.8 m or 30 fathoms) as well as surveying along the 91.4 m (50 fathom) contour (Figure 2). Vessel limitations restricted this survey to depths greater than 54.8 m (30 fathoms). Further vessel restrictions were imposed on the west coast of the Queen Charlotte Islands where modern hydrographic charts are unavailable. Approximately 3334 km (1800 nautical miles) were covered over the duration of the survey.

Major aggregations of herring were identified using a Simrad EK500 38/120 kHz dual-frequency, split-beam hydroacoustic system. The 38 and 120 kHz transducers were mounted on a single retractable ram located near midship which was fully extended (~5.5 m) for all survey work (Kieser et al. 1999). Although data from both transducers were logged for the entire survey, herring (and other fish) biomass will be estimated using the 38 kHz receiver only.

FISHING

Thirty-one mid-water trawls were performed during the two week survey. A CanTrawl model 240 trawl net was used with an approximate mouth opening of 28 m wide by 16 m deep measured acoustically by a Scanmar trawl eye mounted on the headrope. The trawl has a front end of hexagonal web made from 9.5 mm (3/8") and 7.9 mm (5/16") Tenex rope and a tapered body made up of 163 cm (32"), 81.3 cm (16"), 40.6 cm (16"), 20.3 cm (8"), and 10.2 cm (4") polypropylene sections. An intermediate section of 7.6 cm (3") polypropylene and a codend of 3.8 cm (1.5") knotless nylon lined with 64 mm (1/4") mesh make up the lower end of the net. The net is attached to 5 m Jet doors with three 40 m bridles of 1.6 cm (5/8") wire rope per side. It is suggested that a bottom trawl net be included in next year's survey due to the position of some herring schools close to hard bottom and their avoidance behaviour (diving) to the mid-water net.

METHODS AND RESULTS

Biological

When available, two hundred herring were randomly selected and retained for biological sampling from each set. Herring were measured to standard length and weighed to the nearest gram. For selected tows, DNA, stomach and scale samples were taken for additional analyses (Table 2). Other species caught (Table 3) were measured, fork length for salmonids (pink, chinook, chum, and coho salmon), total length for groundfish (hake, Pacific cod, pollock, and arrowtooth flounder), and standard length for pelagics (eulachon).

A total of 3347 herring were measured and weighed from 17 sets (Figure 3). Length frequency data (Figure 4) in combination with herring ages from scale samples will be used to develop a forecasting tool for recruitment strength for northern herring stocks. Comparisons with previous northern cruises (i.e., Thompson et al. 2004) are now possible (but beyond the scope of this report). Main summer aggregations of herring were found from Dundas Island (set 18) in the north down through Hecate Strait (primarily lying along the 50 fathom contour) to the Estevan Group (set 26) in the south. Smaller herring aggregations were identified in southern Queen Charlotte Sound on Goose Island Bank. This is similar to findings from the summer herring survey in 2003 (Thompson et al. 2004).

Herring scales were collected and mounted following the protocol developed by Hamer (1989). For each fish, the preferred aging scale located under the pectoral fin on the left side of the fish was removed and mounted on a glass slide using a diluted mucilage mixture. Scales were removed from a total of 843 fish from ten separate sets for age analysis and size-at-age determination (Figure 5). These results are similar to previous summer herring surveys. Mean lengths, weight and percent composition by age are shown in Table 4 and length – weight correlation in Figure 6. This length – weight

correlation is a better fit (r^2 value) than previous surveys in Hecate Strait. On two occasions (sets 13 and 22), large herring (>200 mm) were selectively collected and scales removed for aging to determine upper age limits. No pre-recruit (age-2+) herring were landed in these sets. In contrast, some sets were dominated by pre-recruit herring. For example, Set 1 from Queen Charlotte Sound resulted in the highest catch composition of age-2+ herring (83%), followed by set 11 (60%) from mid-Hecate Strait and set 26 (53%) from southern Hecate Strait (Table 4). No herring were observed along the west coast of the Queen Charlotte Islands.

DNA was collected following established protocols (Beacham et al. 2002). Fish were wiped clean using a cloth to remove scales and excess mucus and a corer was used to obtain a sample of epaxial muscle. The core sample was then preserved in 95% ethanol. DNA was collected from 100 herring from two different spatial locations in Goose Island Bank and Hecate Strait, resulting in the collection of 200 individual DNA samples. These samples will be used in ongoing investigations of herring population structure for northern stock assessment areas.

A total of 250 herring stomachs were retained from four sets (15, 17, 23, 28) for gut content (diet) analyses. Stomachs were removed and preserved in 4% formaldehyde (mixture of freshwater and 37% formalin). Stomachs from species other than herring also were sampled and all identifiable gut species were measured to total length.

Pacific hake (*Merluccius productus*) were the second most common fish species encountered during this survey and could represent an important herring predator. Sets 4, 8, 9, 20 and 29 resulted in hake being the predominant species captured. Northern summer aggregations of hake are mainly made up of larger females (DFO 2003). Thus, fish were sorted by sex to display the sex ratio separation prior to sub-sampling for total length (cm) measurements (Figure 7). By the late 1990's, the center of summer feeding and winter spawning distributions shifted north with hake found as far north as the Gulf of Alaska (DFO 2003). This survey captured hake at our most northern set near Dundas Island (set 19). Hydroacoustic images of hake schools are extremely similar to herring schools with depth being the primary factor allowing species-specific classification of unknown school targets (Figure 8). Further, it is necessary to ground-truth any questionable hydroacoustic images to determine species composition in these unknown aggregations. In general, hake and herring did not co-occur (Table 3) with most herring encountered in shallower water areas and most hake encountered in deeper water areas (Figures 2 and 3). Thus, at least in northern waters, the potential predator-prey relationship between hake and herring might not be significant.

Oceanographical

To characterize oceanographical conditions in the surveyed area, a total of 34 CTD (conductivity – temperature – density) casts were made using a Sea-bird model SBE-911plus (Figure 9). A CTD was performed at the start of each day as well as at each set which resulted in a quantifiable amount of herring. All CTDs were cast to within 3 to 5 m of the bottom. The CTD provided a range of data for temperature (^{o}C),

transmissivity (%/m), fluorescence (mg/m^3) and salinity (ppt) based on depth (m) (Figure 10). Transmissivity is the ability of water to transmit light along a straight path. Any incident light attenuated, scattered, or absorbed decreases the transmissivity of the water. Transmissivity is reported in percent of light returning to the receiver per meter (%/m). Fluorescence is used to determine the location of the phytoplankton layer (mainly diatoms) in the water column and is reported in milligrams of chlorophyll *a* per cubic meter of water (mg/m^3). In general, transmissivity peaked near the surface and fluorescence peaked between 10 and 30 metres.

CONCLUSIONS

The survey covered approximately 3334 km (1800 nautical miles) around the northern coast of British Columbia. Major summer aggregations of herring were found from Dundas Island in the north down through Hecate Strait (primarily lying along the 50 fathom contour) to the Estevan Group in the south. Smaller herring aggregations were identified in southern Queen Charlotte Sound on Goose Island Bank. Continuation of this survey would be beneficial for the understanding of summer herring spatial distributions, feeding, amount of stock mixing, and recruitment strength forecasting for northern herring stocks.

ACKKNOWLEDGMENTS

The authors would like to thank the skipper, David Wensley, and the crew of the CCGS *W.E. Ricker*. Additional sampling support from Peter Midgley, Mark Potyrala and Steve Groves and hydroacoustic support from Ken Cooke were much appreciated. We gratefully acknowledge financial support from the Herring Conservation and Research Society (HCRS) for making this research possible.

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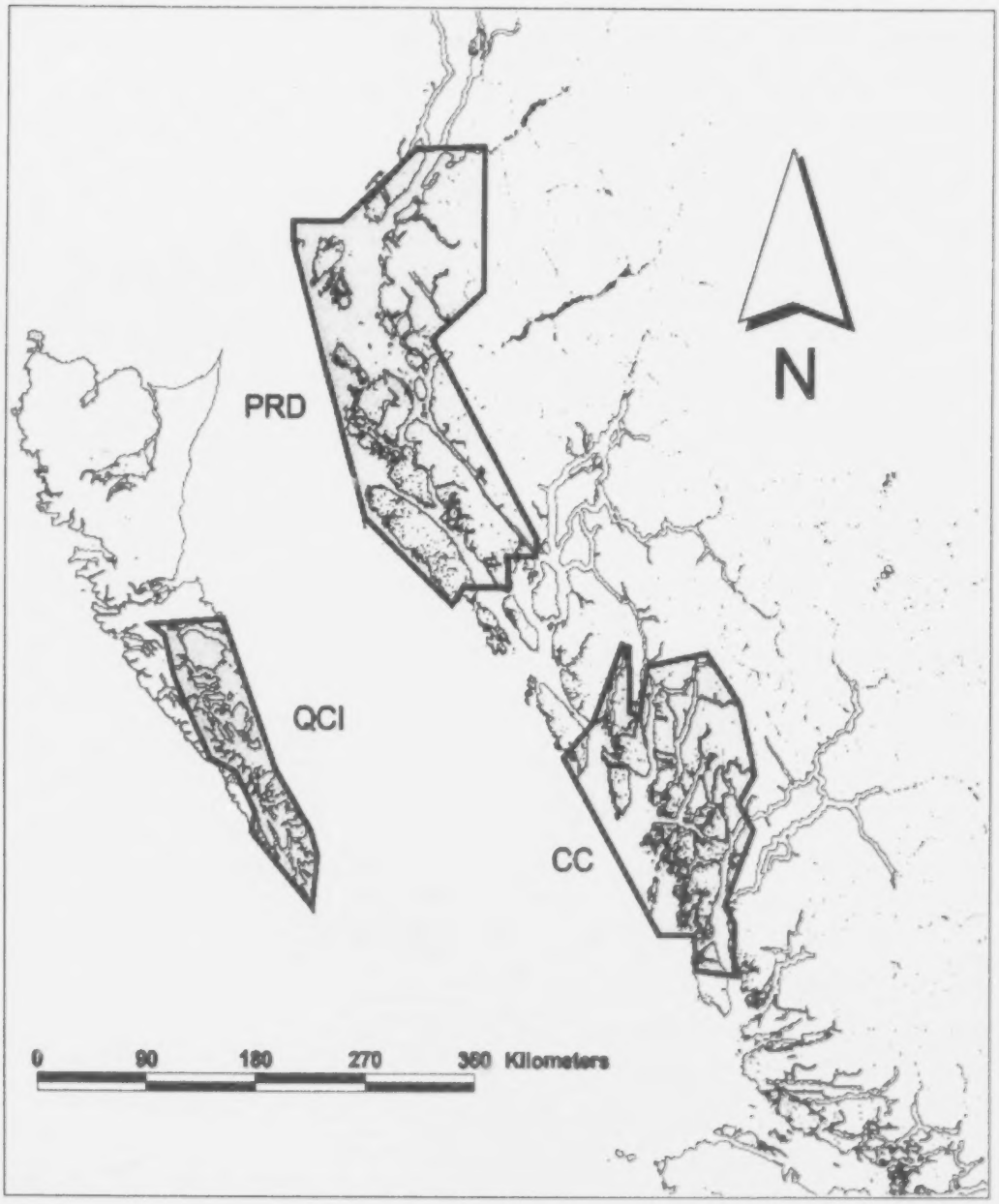


Figure 1. The three northern herring stock assessment regions. Queen Charlotte Islands (QCI), Prince Rupert District (PRD) and Central Coast (CC).

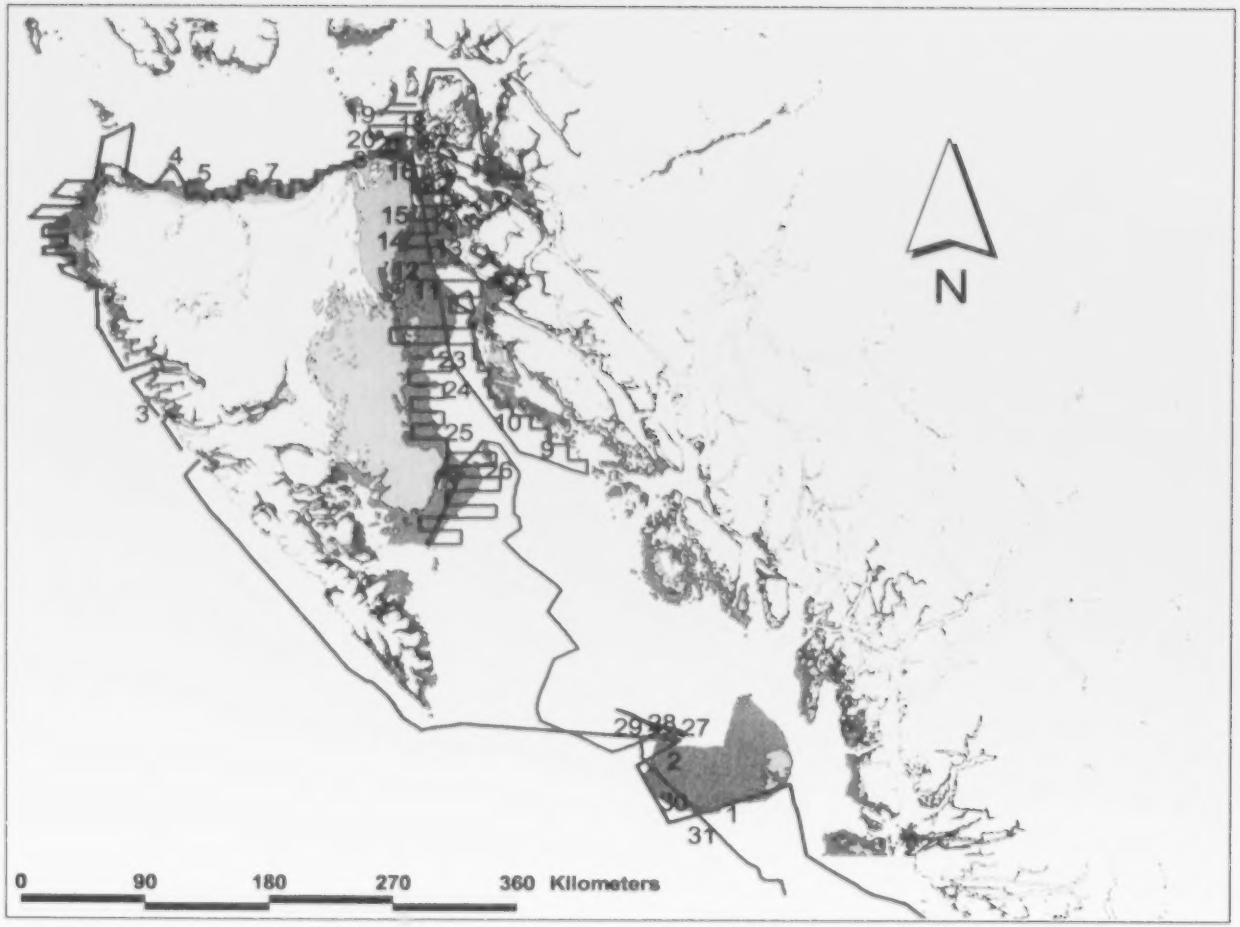
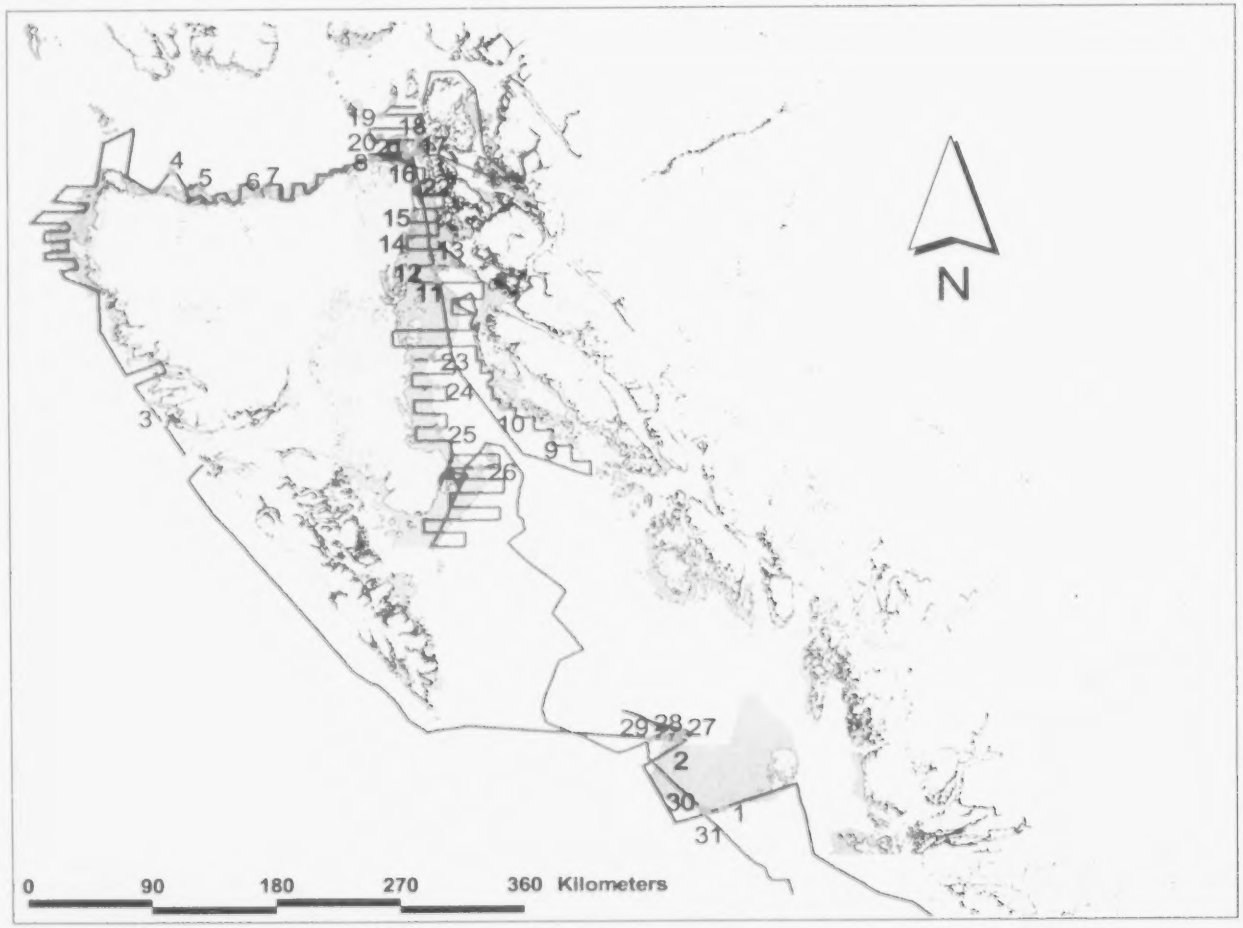


Figure 2. Map of Queen Charlotte Sound, Hecate Strait and the Queen Charlotte Islands showing cruise path (line) and all fishing locations (numbers). Dark shading represents 50 to 100m and lighter shading is 30 to 50m depth.



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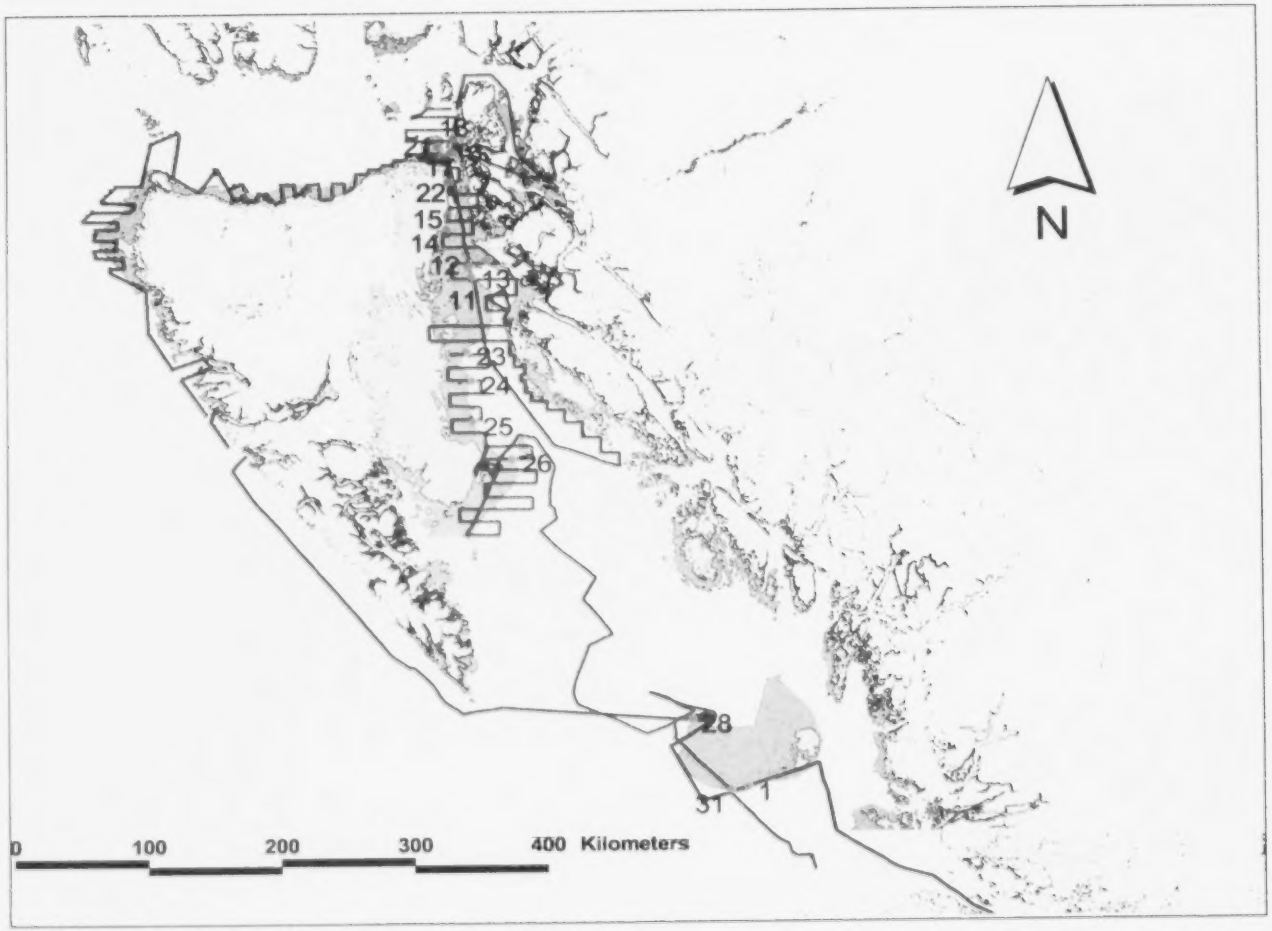
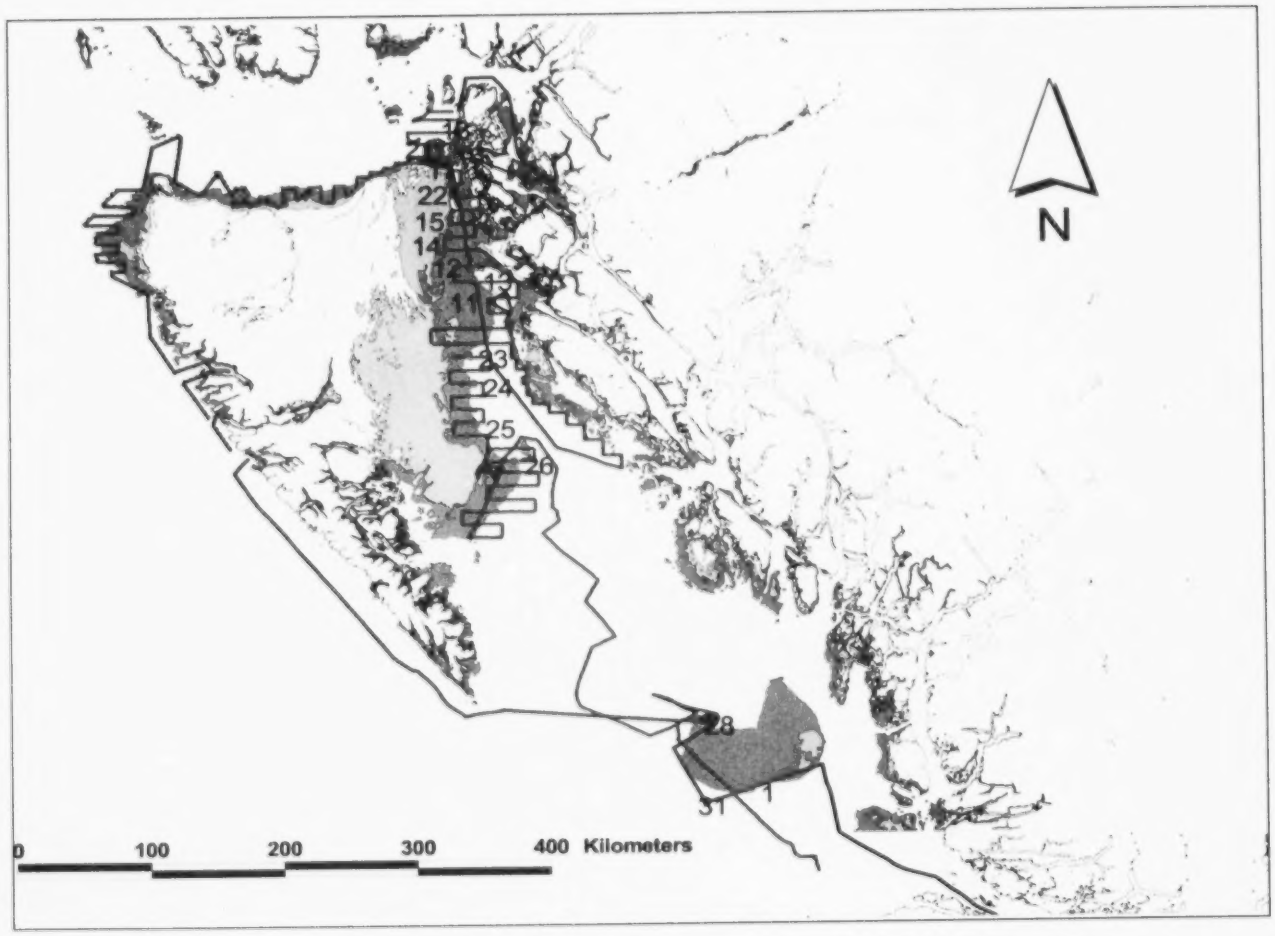


Figure 3. Map of Queen Charlotte Sound, Hecate Strait and the Queen Charlotte Islands showing cruise path (line) and fishing locations where herring were caught (numbers). Dark shading represents 50 to 100m and lighter shading is 30 to 50m depth.



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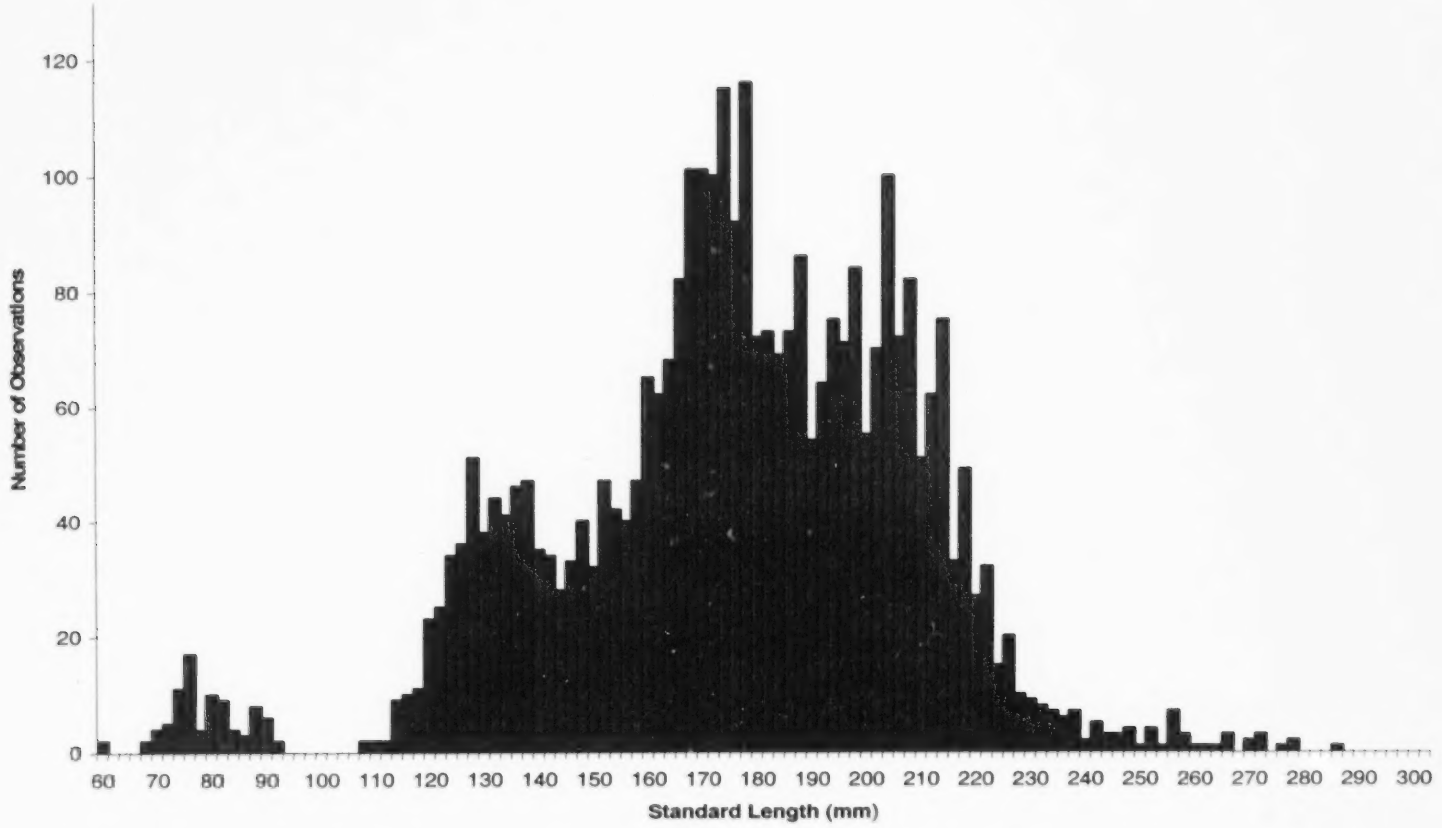


Figure 4. Length frequency distribution of all sampled (n=3347) herring from 17 mid-water tows.

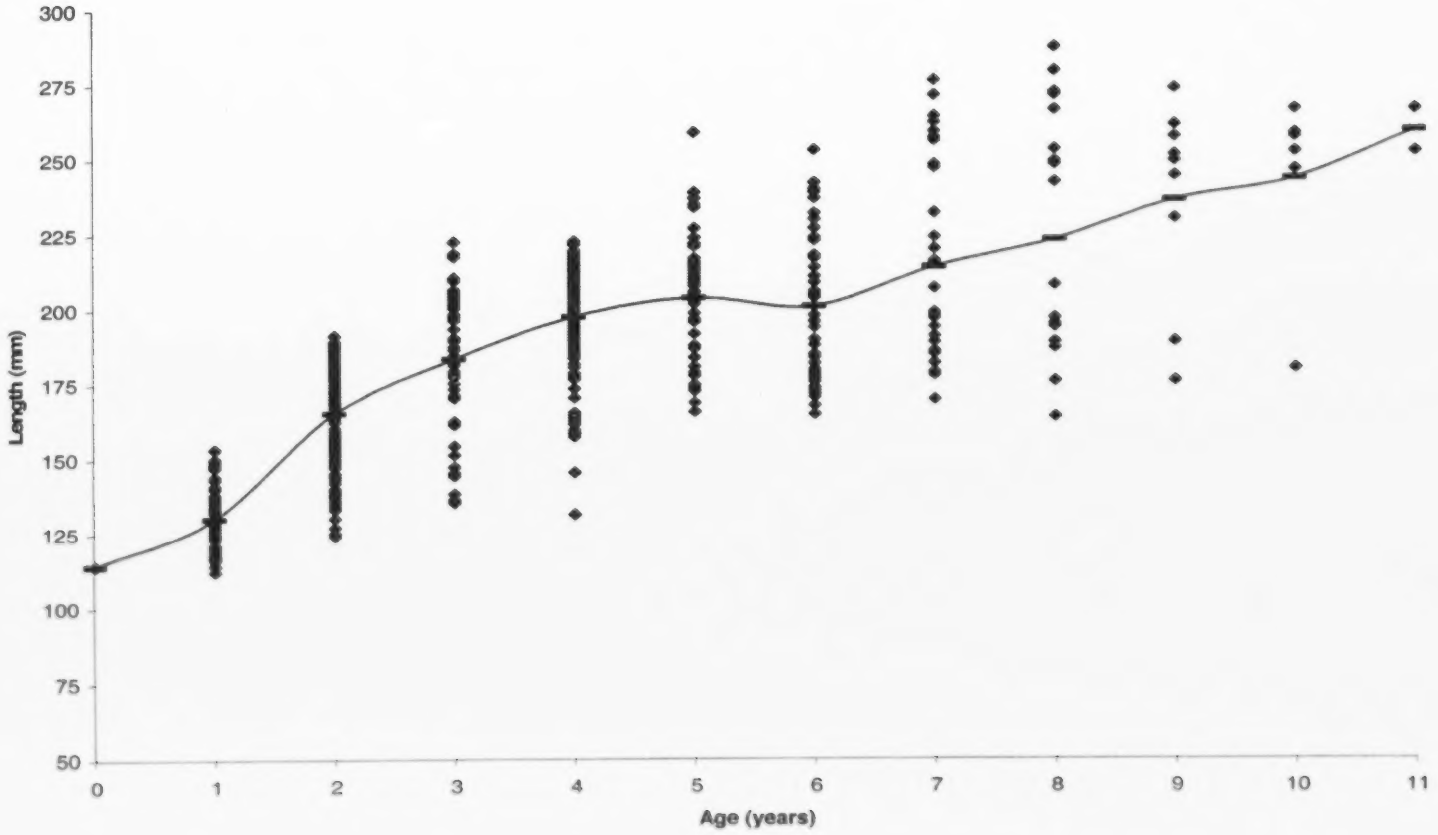


Figure 5. Herring size-at-age distribution. Trend line follows mean lengths at each age.

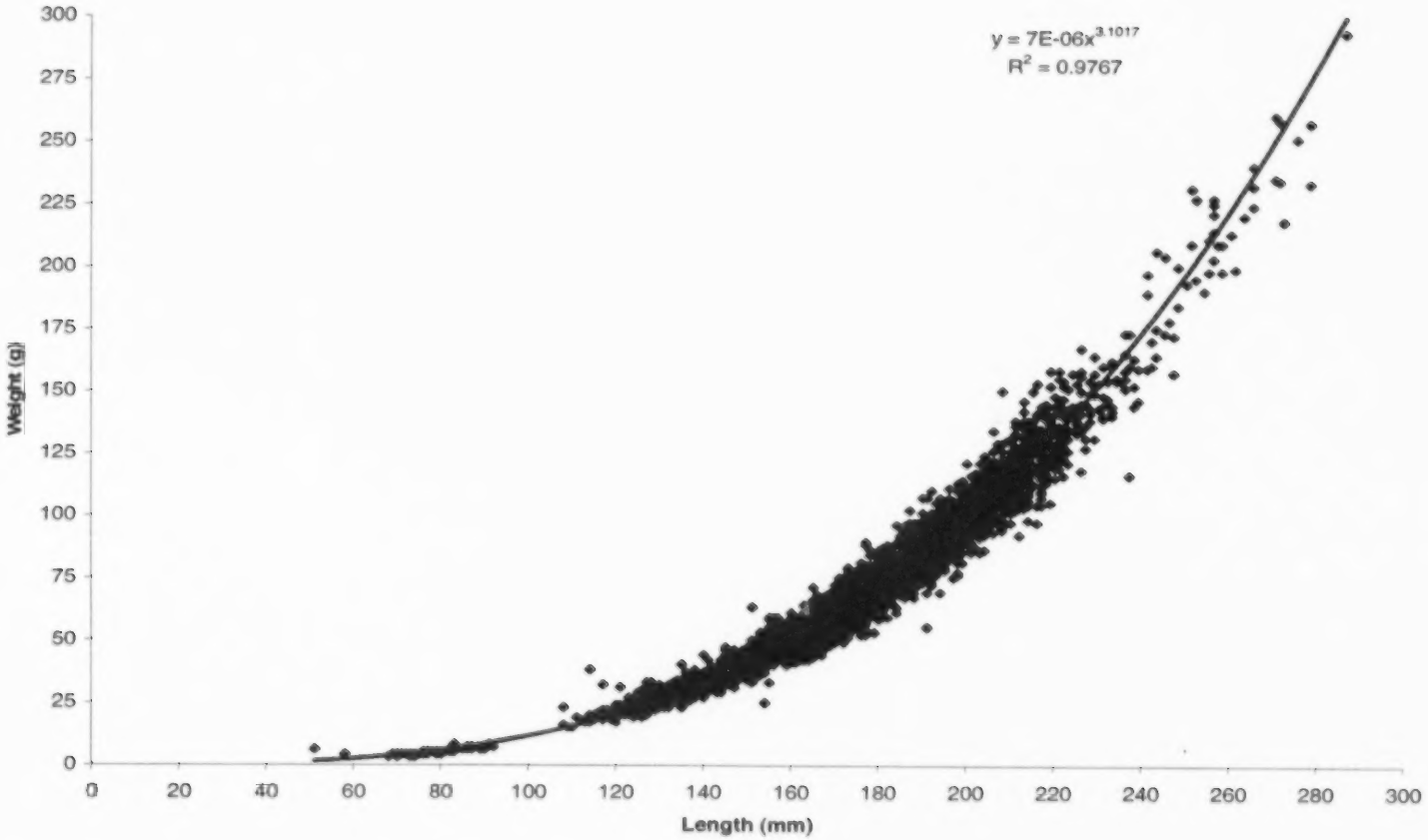


Figure 6. Length-weight relationship for all sampled herring (n=3347).

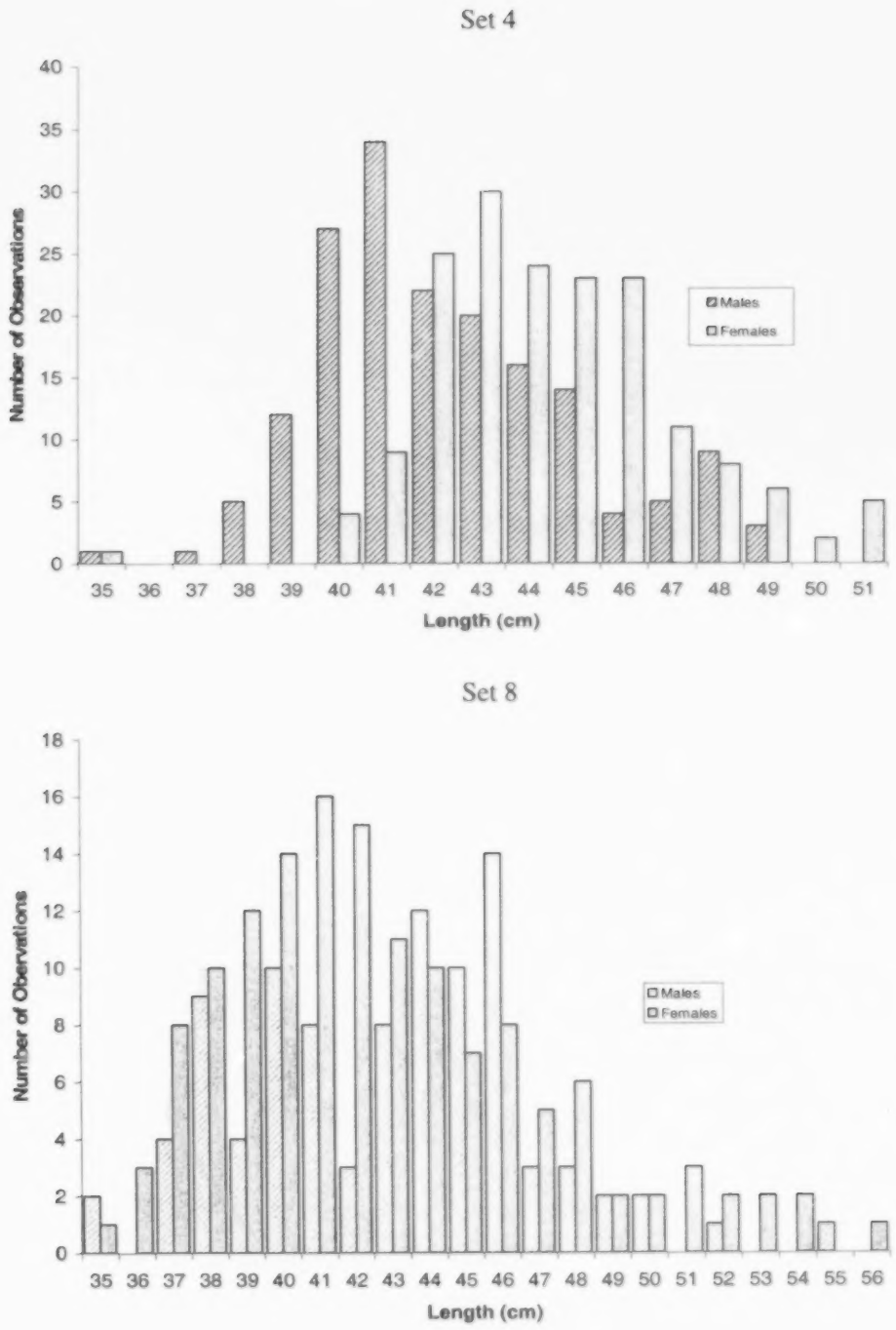
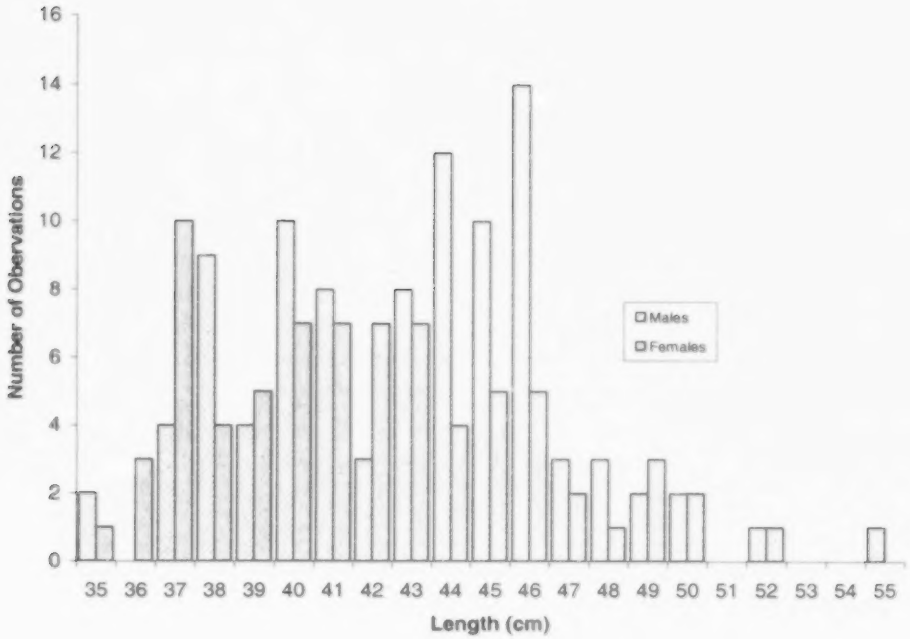


Figure 7. Length-sex relationship for all sampled hake.

Set 9



Set 20

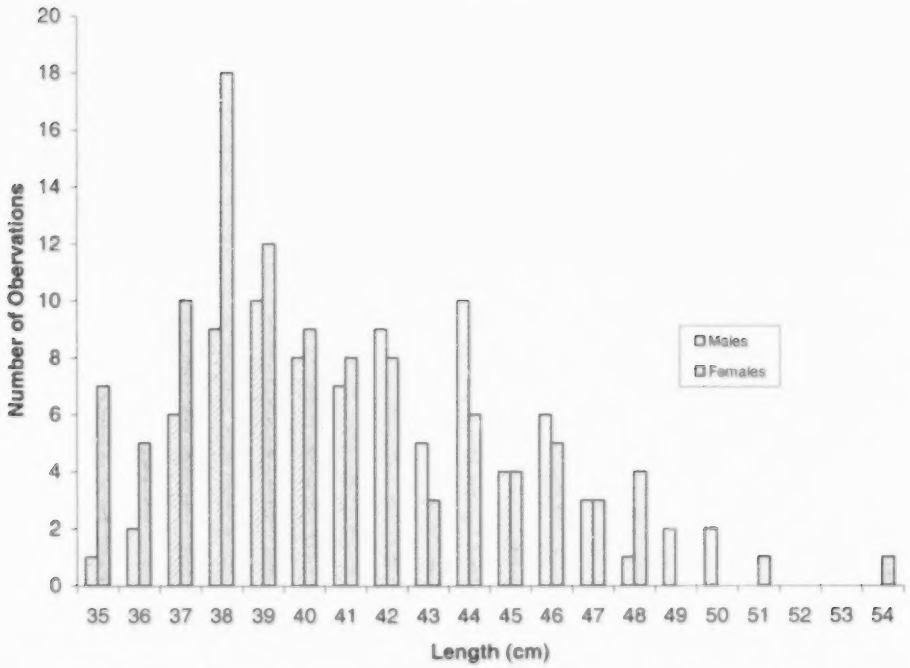
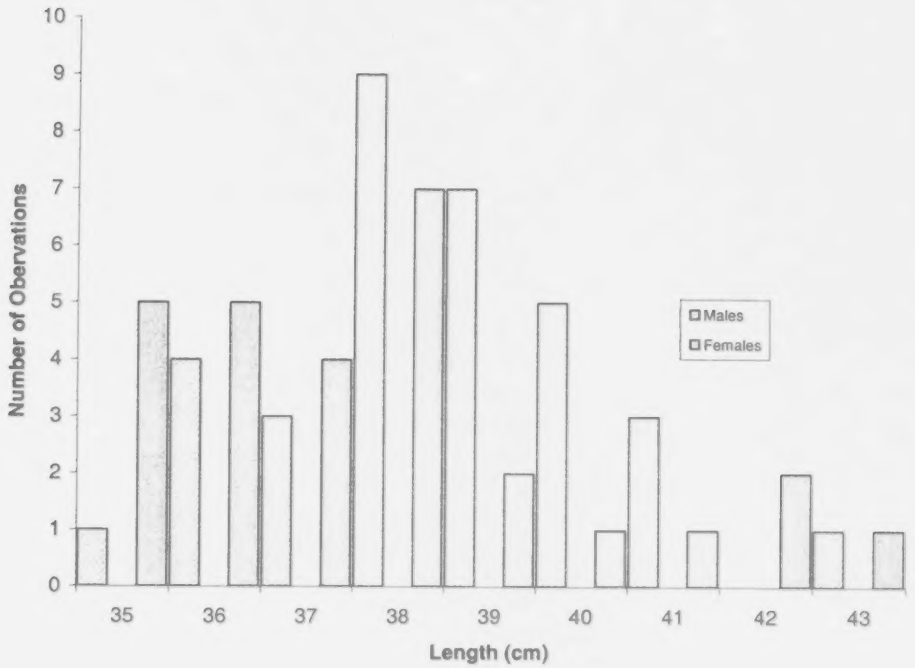


Figure 7 continued…

Set 29



All sets combined

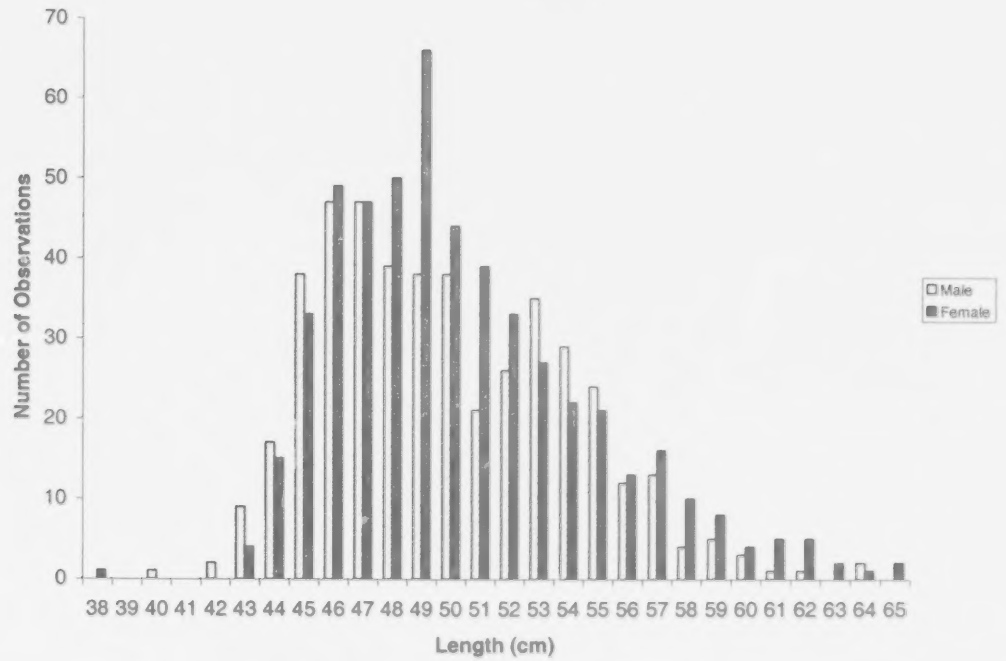


Figure 7 continued…

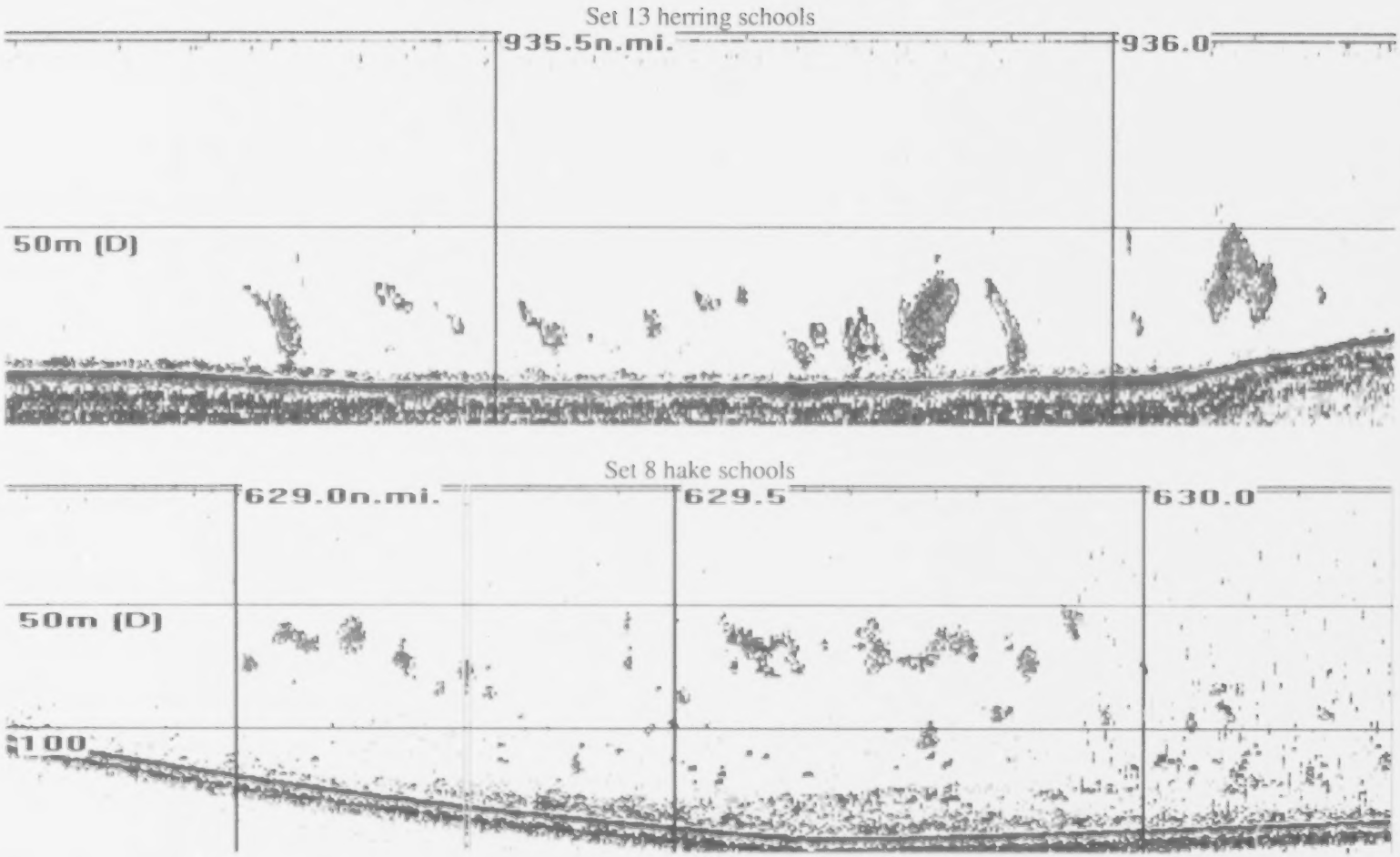


Figure 8. Hydroacoustic sounding images of herring schools (top, set 13) versus hake schools (bottom, set 8).

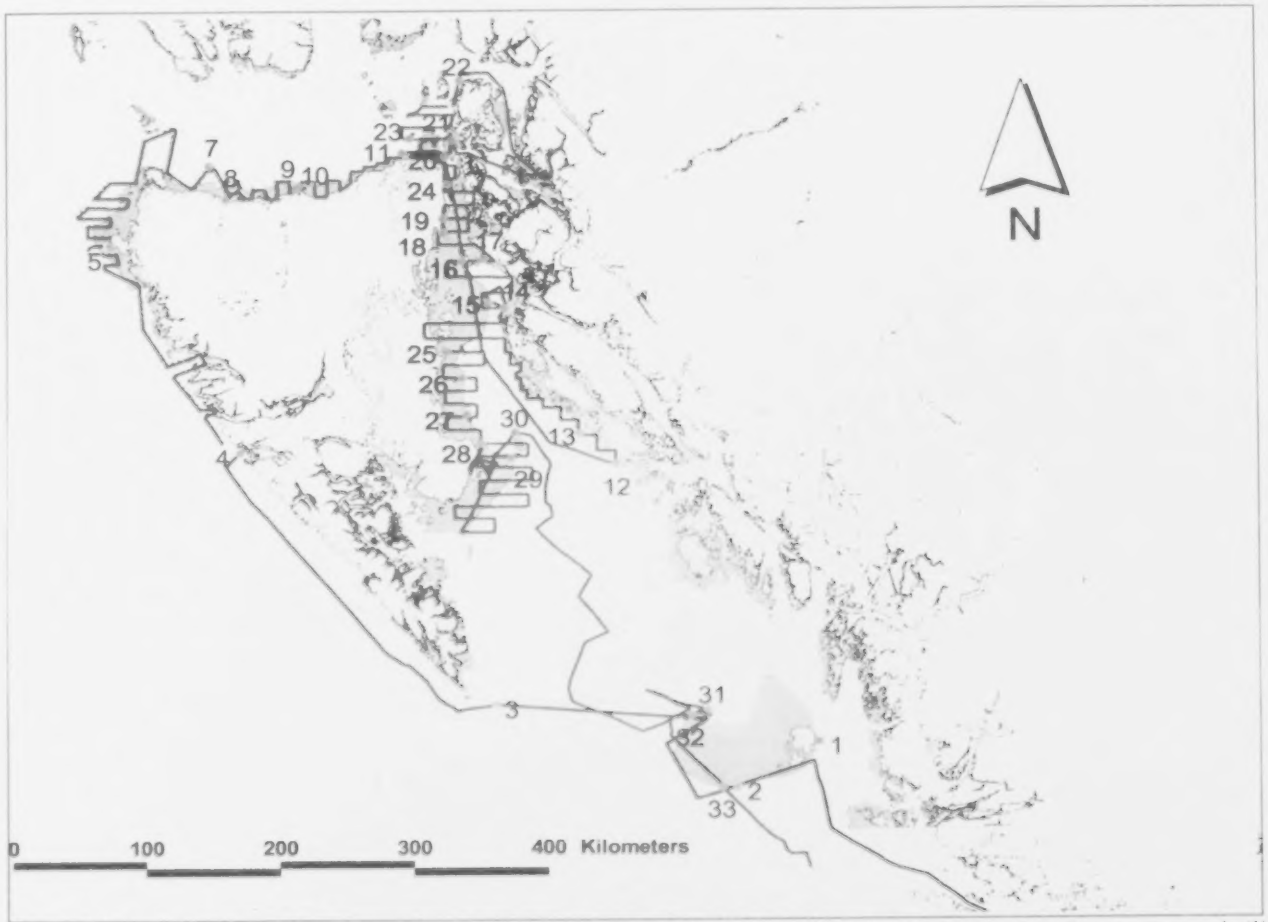


Figure 9. Map of Queen Charlotte Sound, Hecate Strait and the Queen Charlotte Islands showing cruise path (line) and all CTD locations (numbers). Dark shading represents 50 to 100m and lighter shading is 30 to 50m depth.

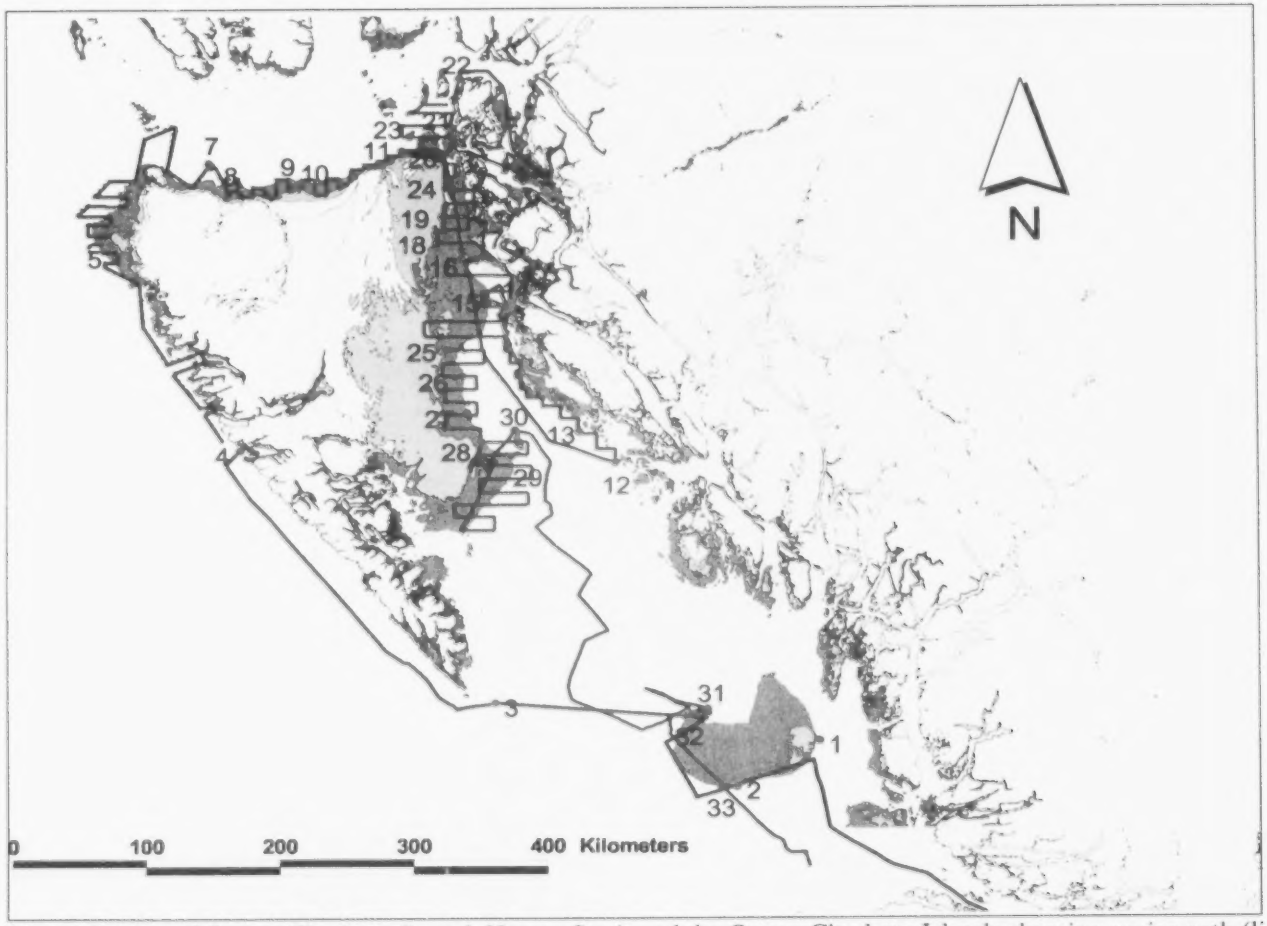
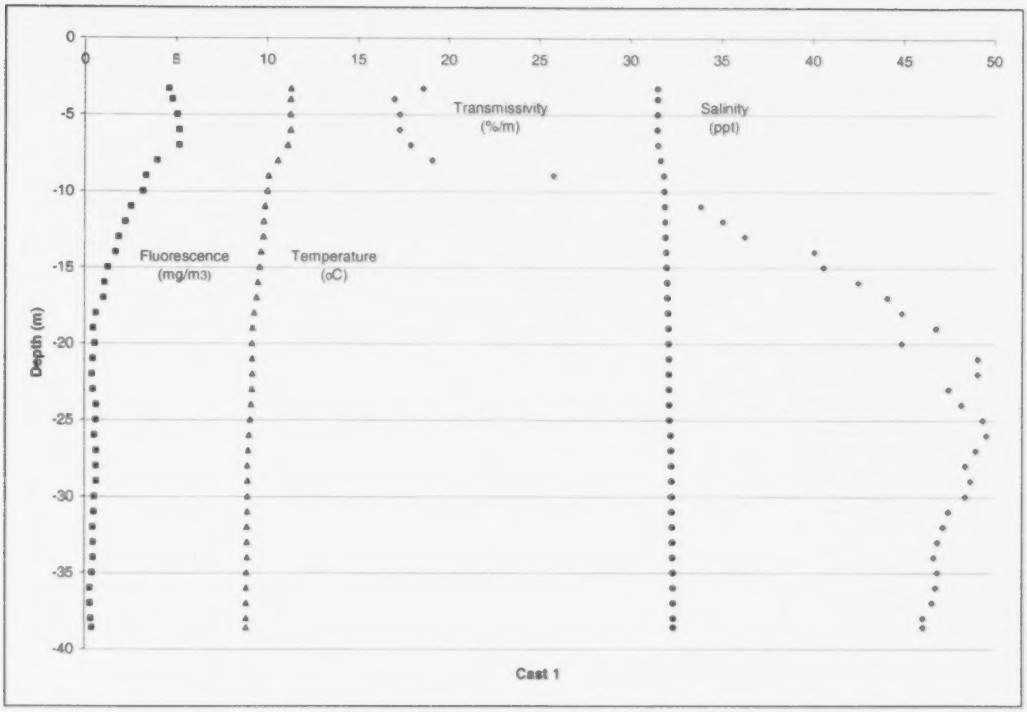


Figure 9. Map of Queen Charlotte Sound, Hecate Strait and the Queen Charlotte Islands showing cruise path (line) and all CTD locations (numbers). Dark shading represents 50 to 100m and lighter shading is 30 to 50m depth.



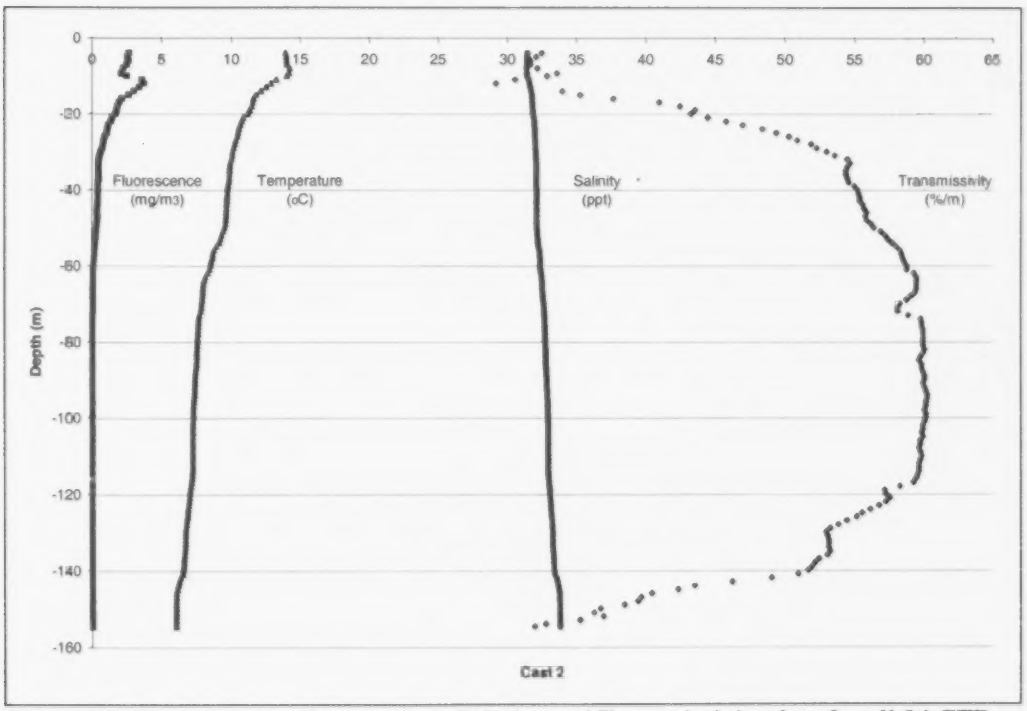
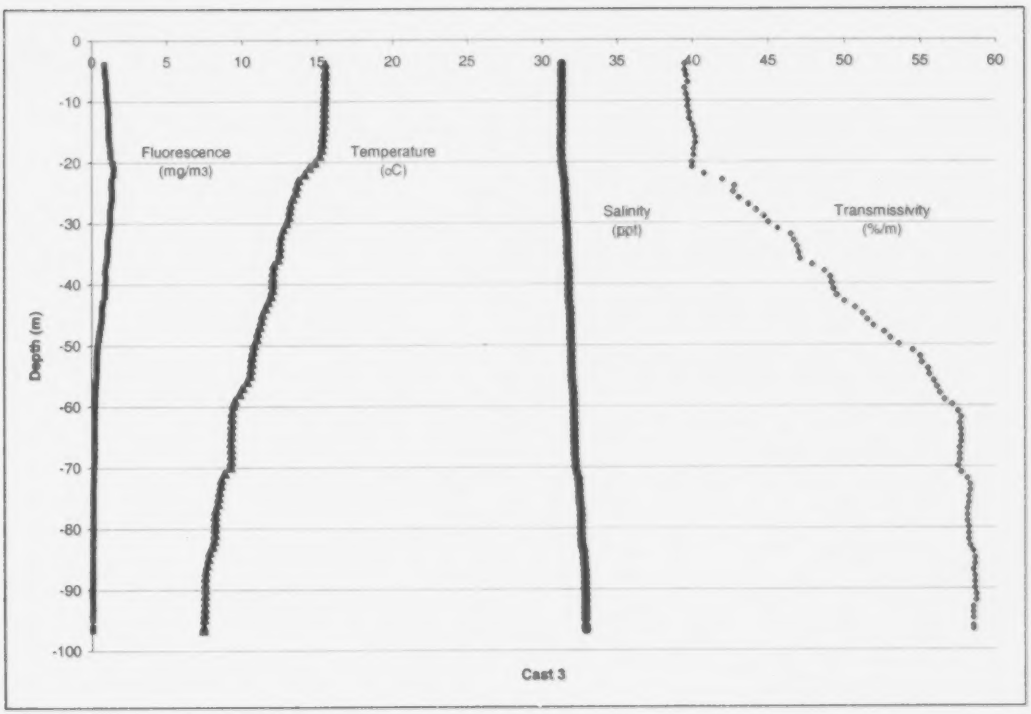
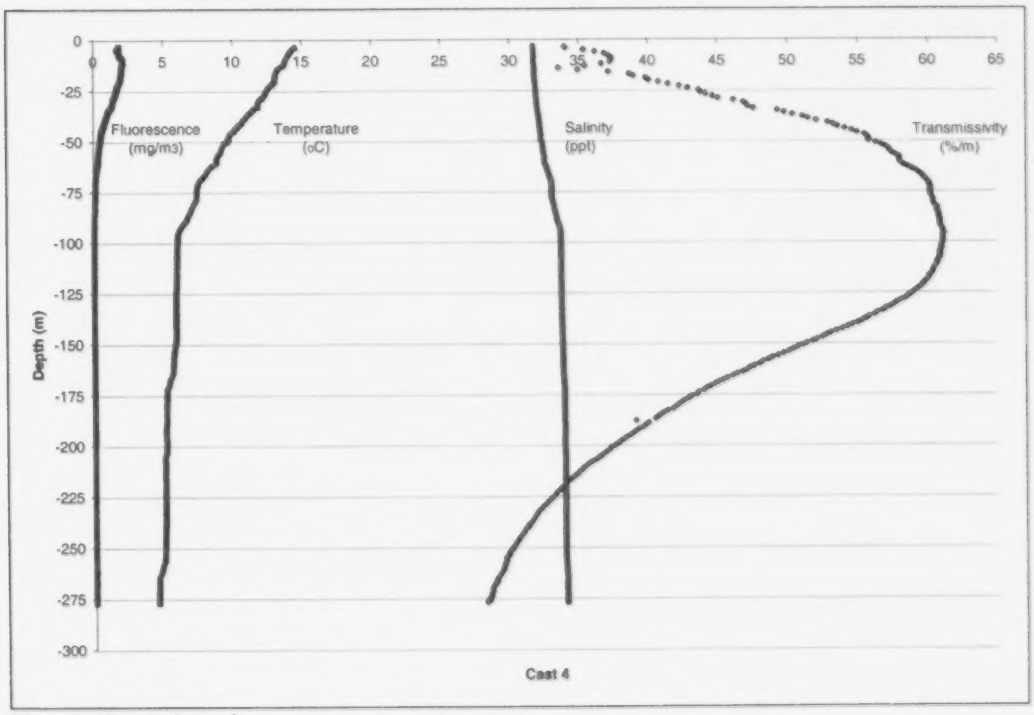


Figure 10. Fluorescence, Temperature, Salinity and Transmissivity data for all 34 CTD casts.





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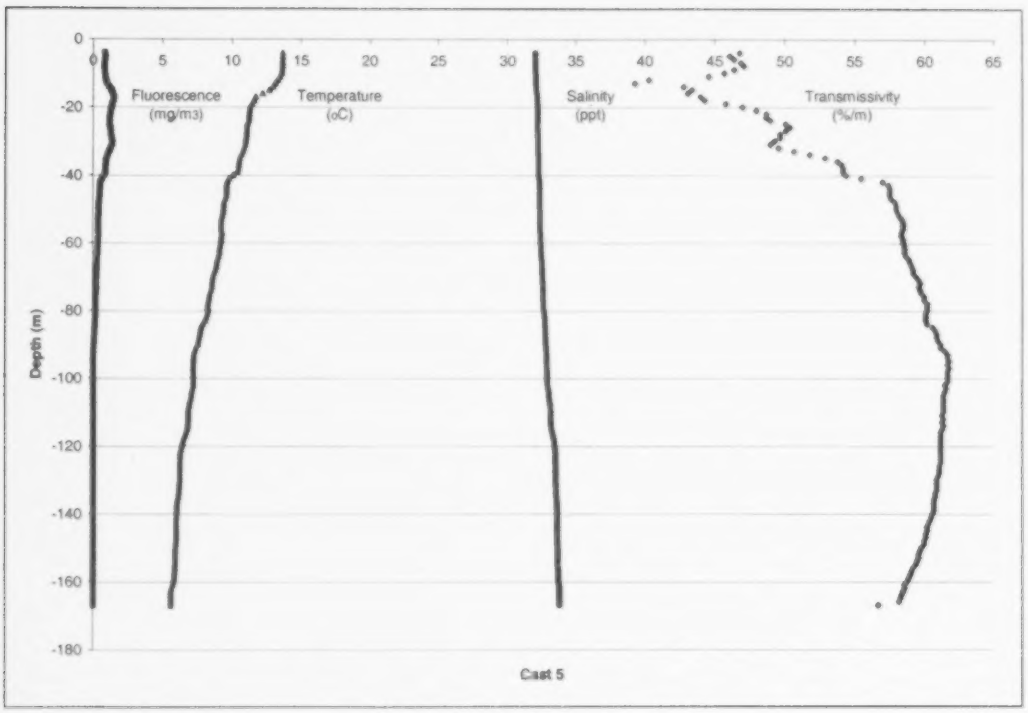

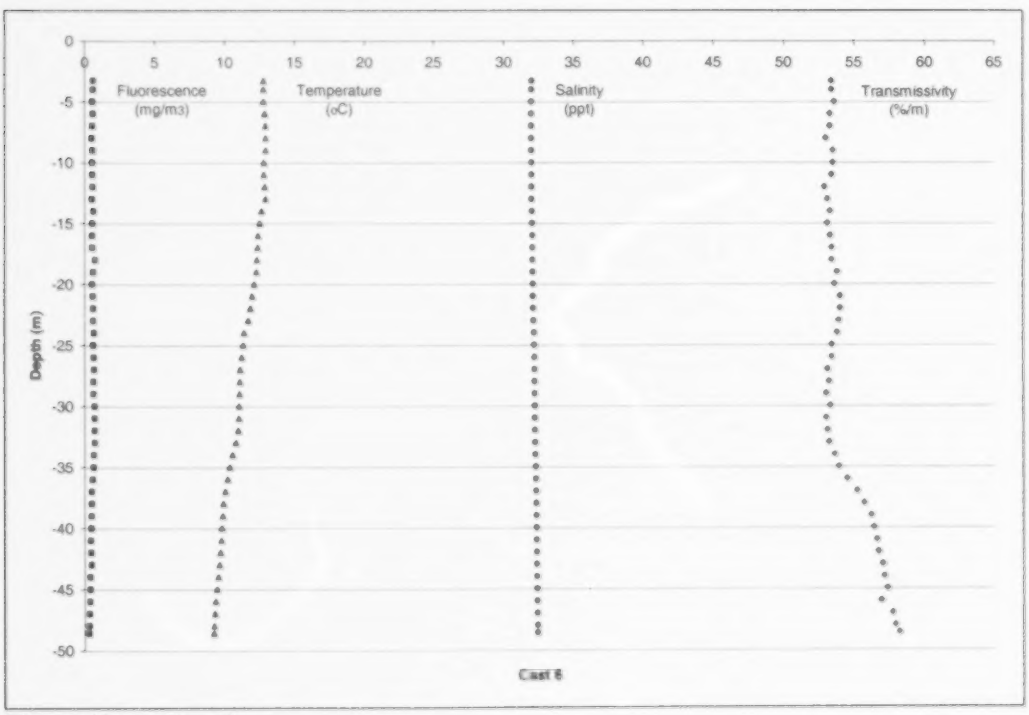

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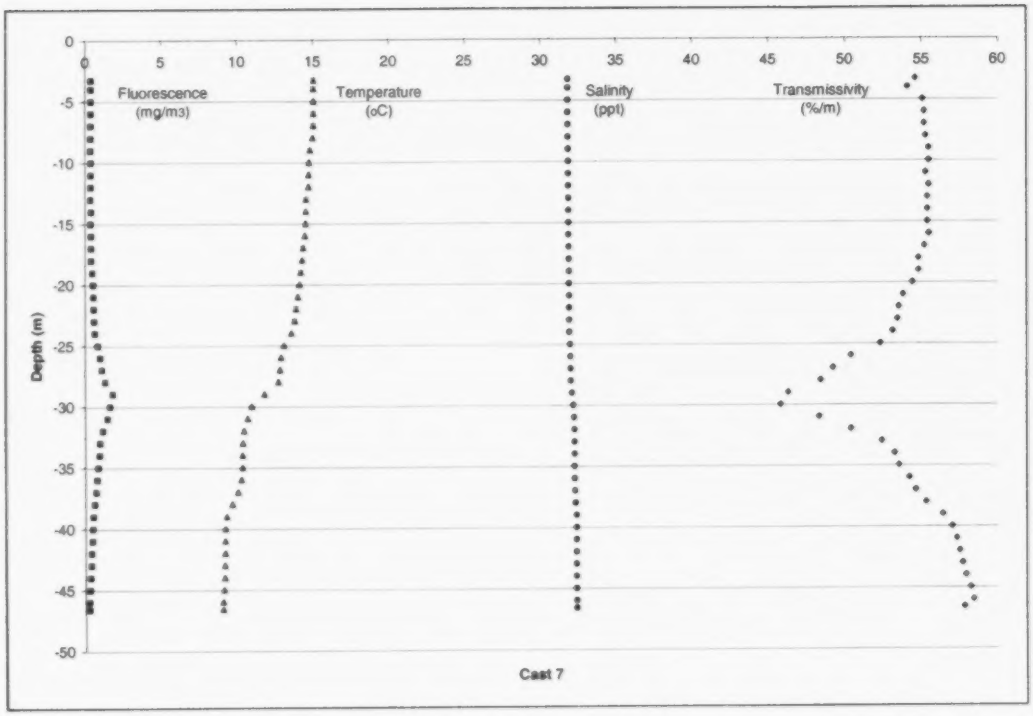

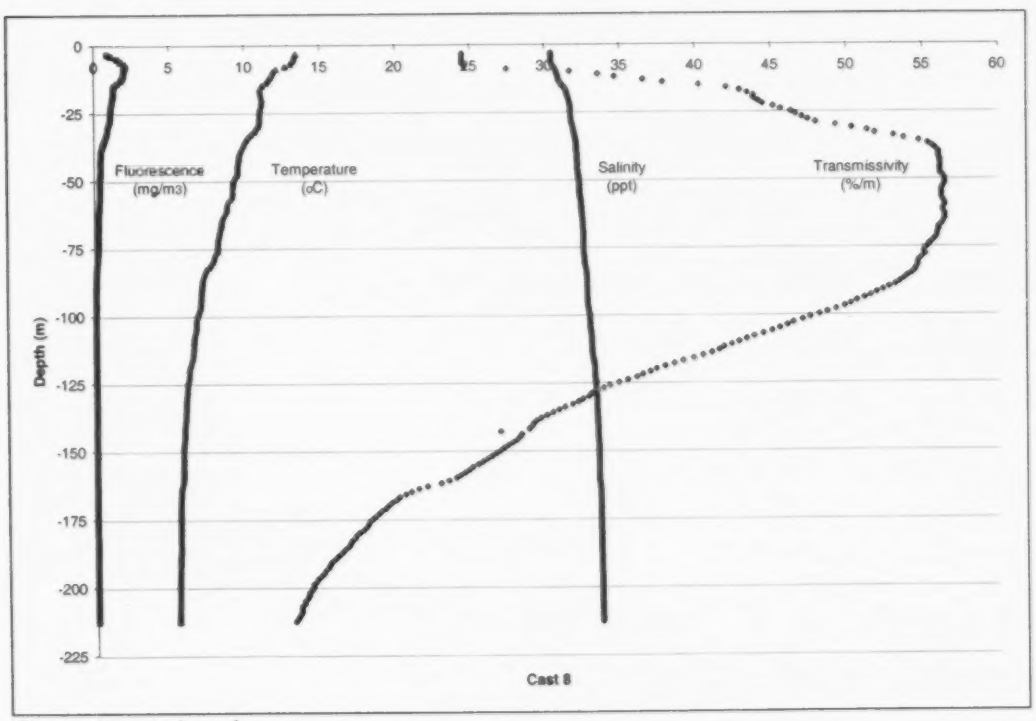

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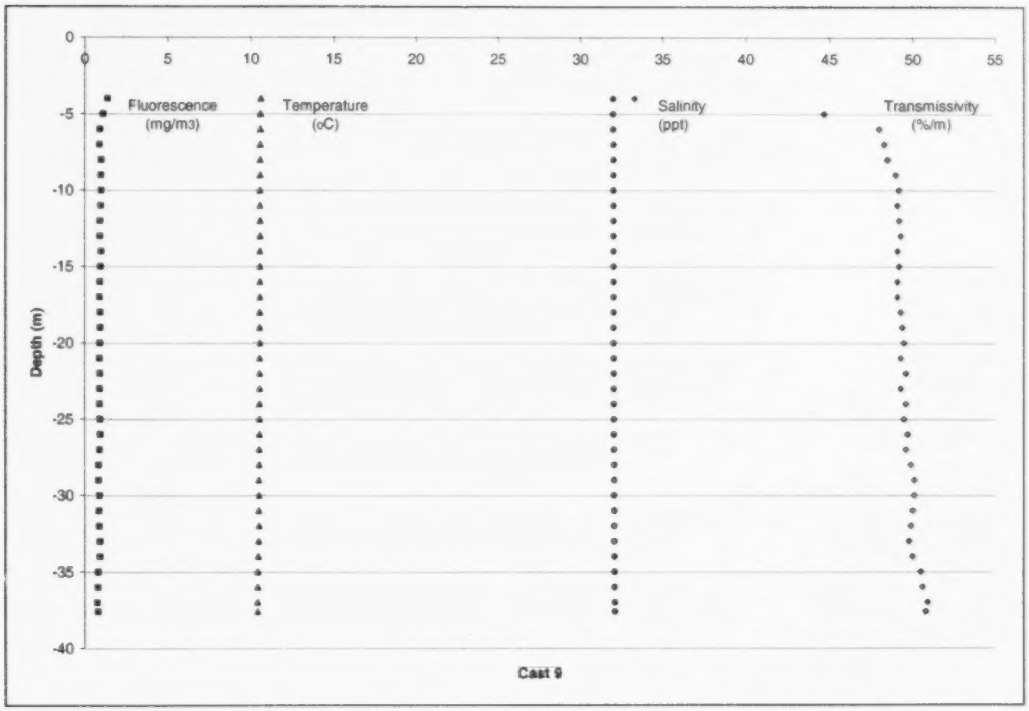

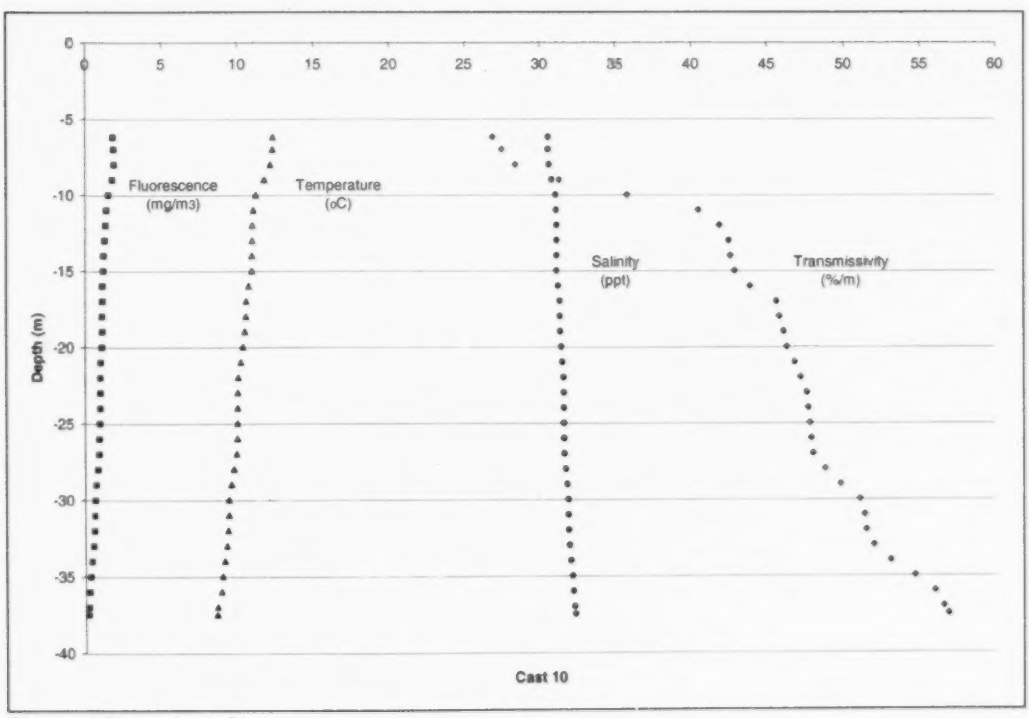

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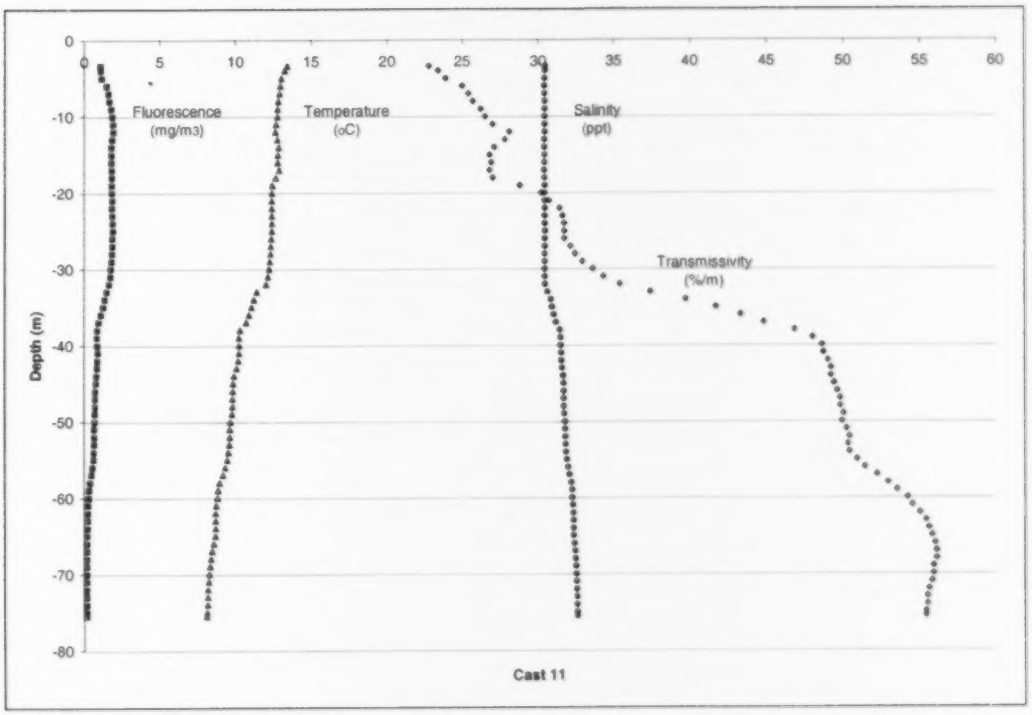

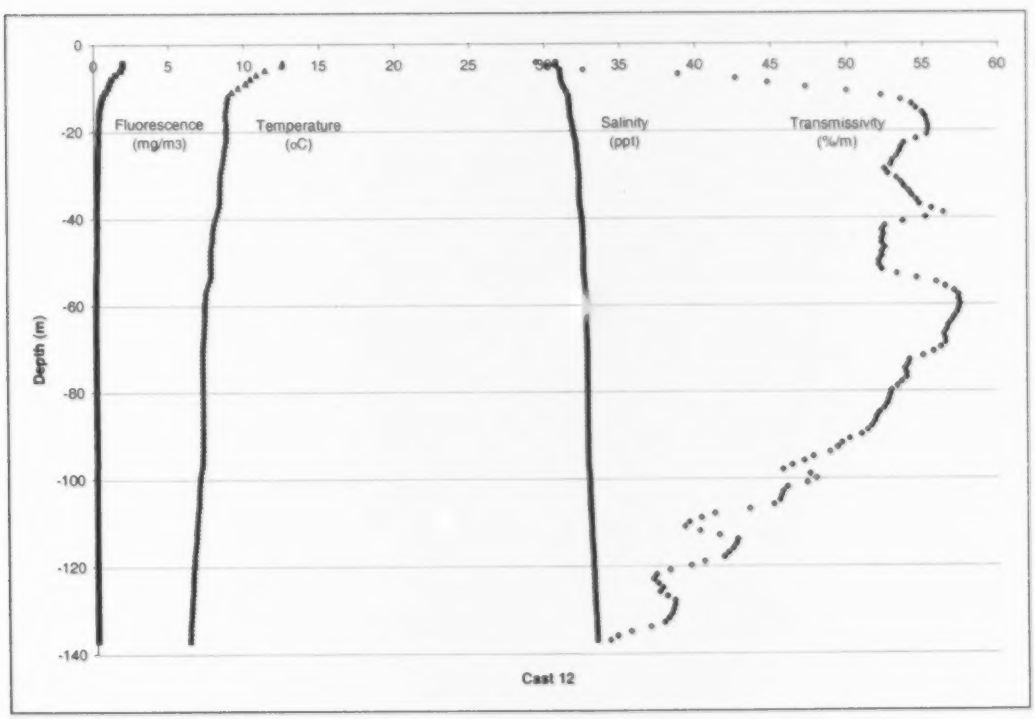

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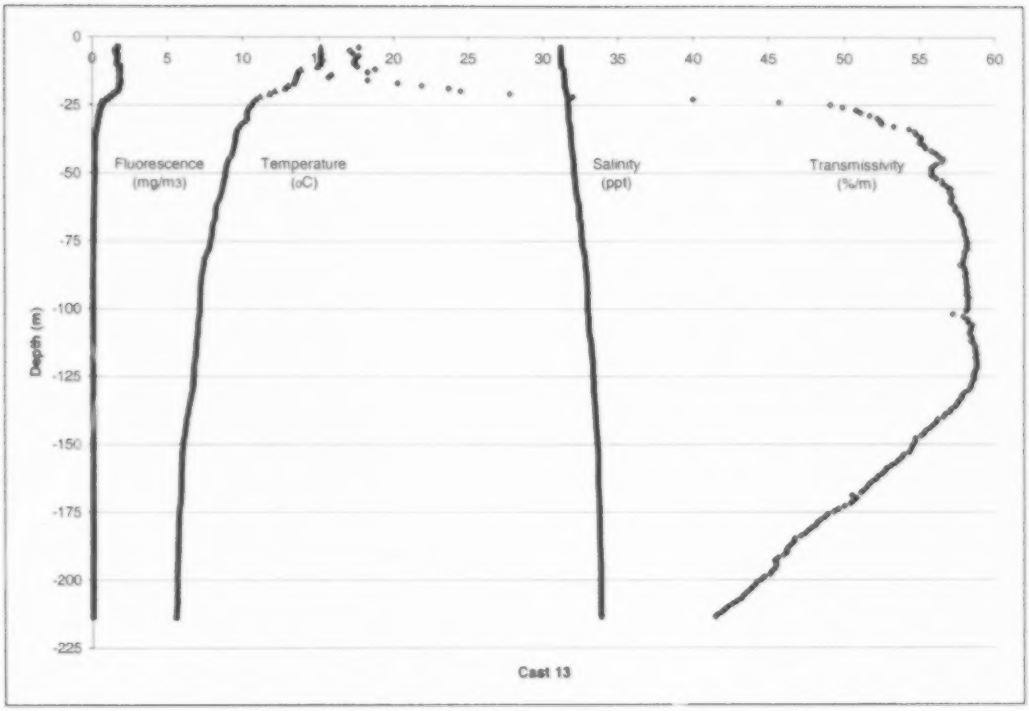

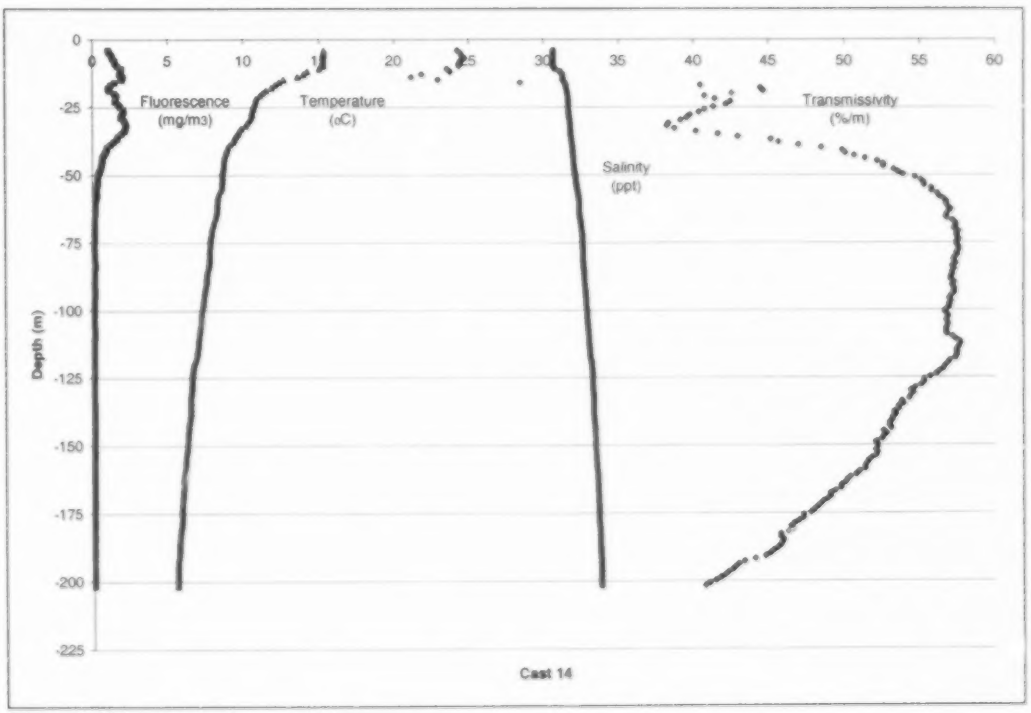

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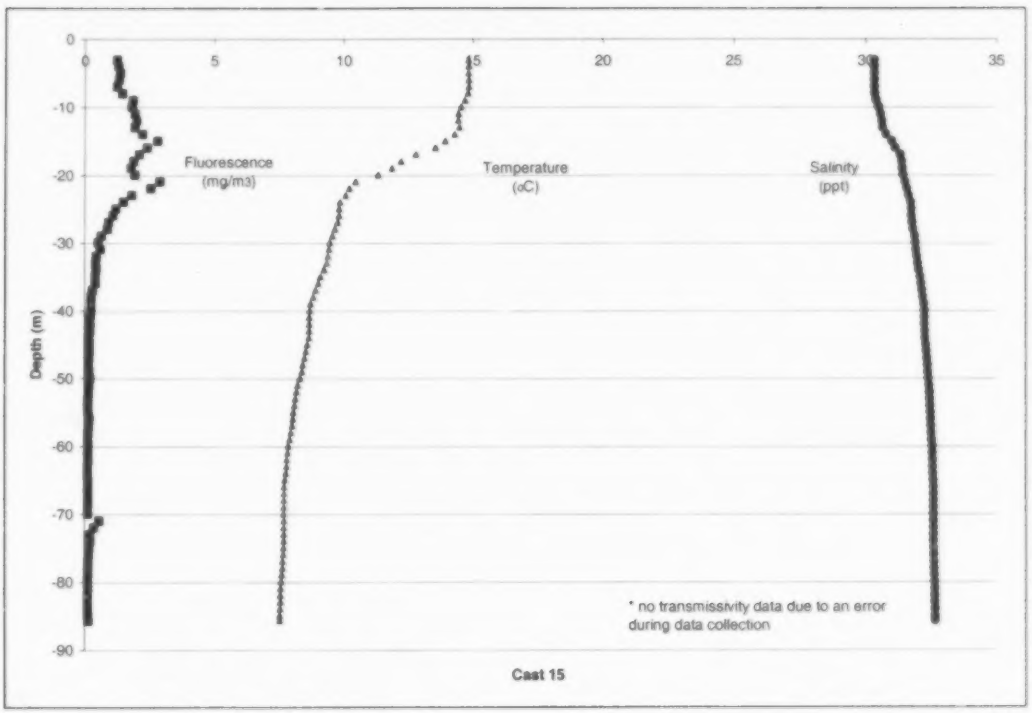

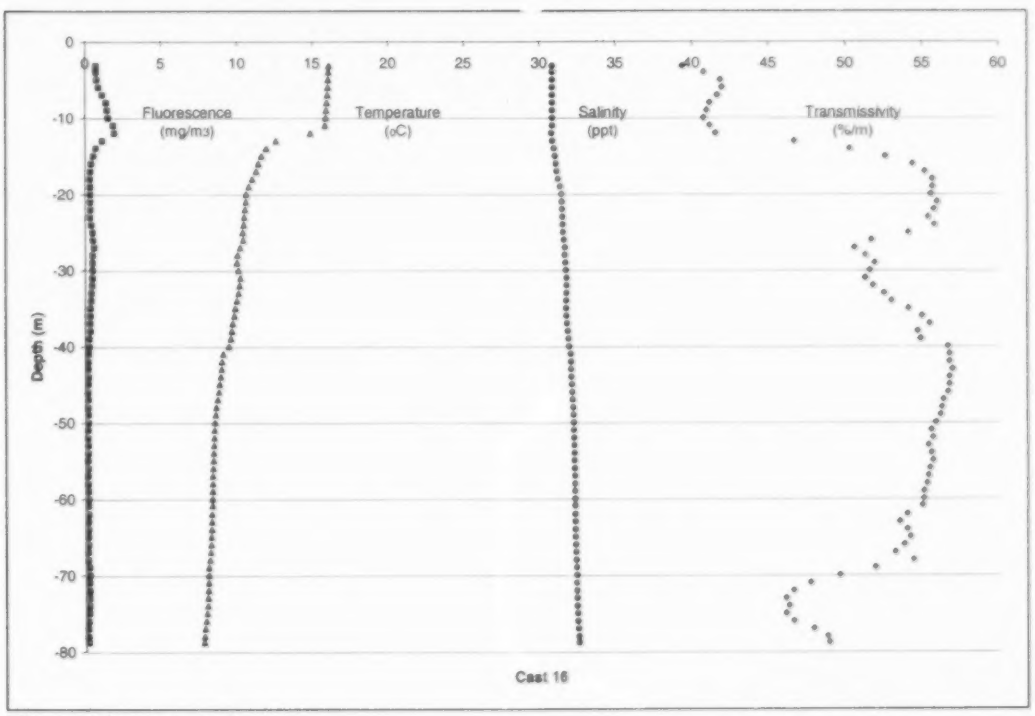

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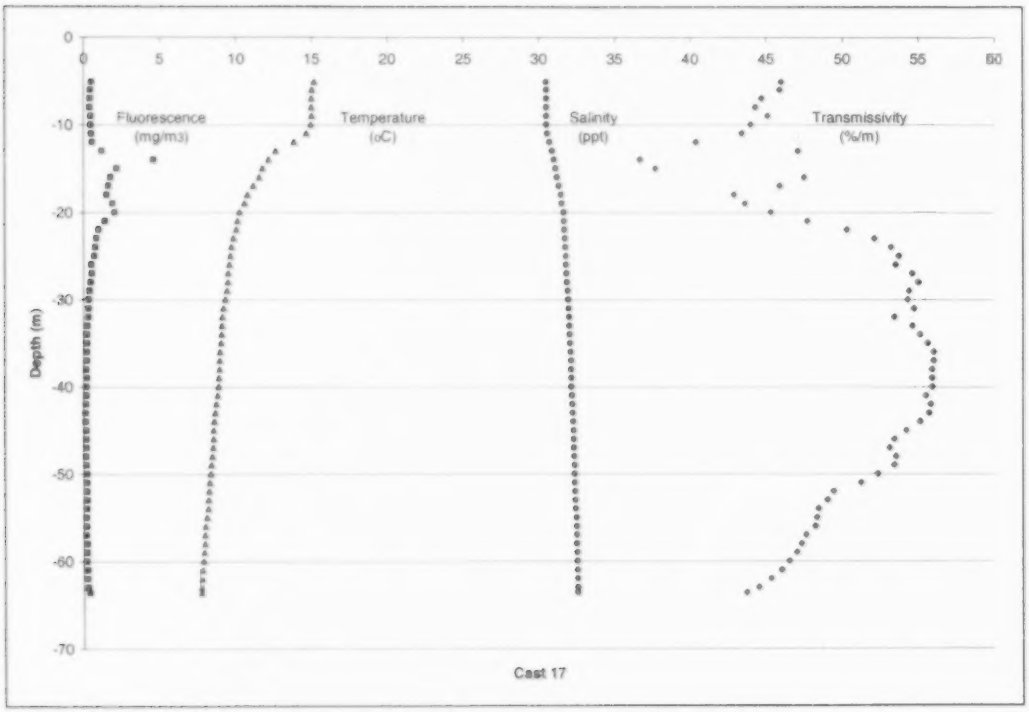

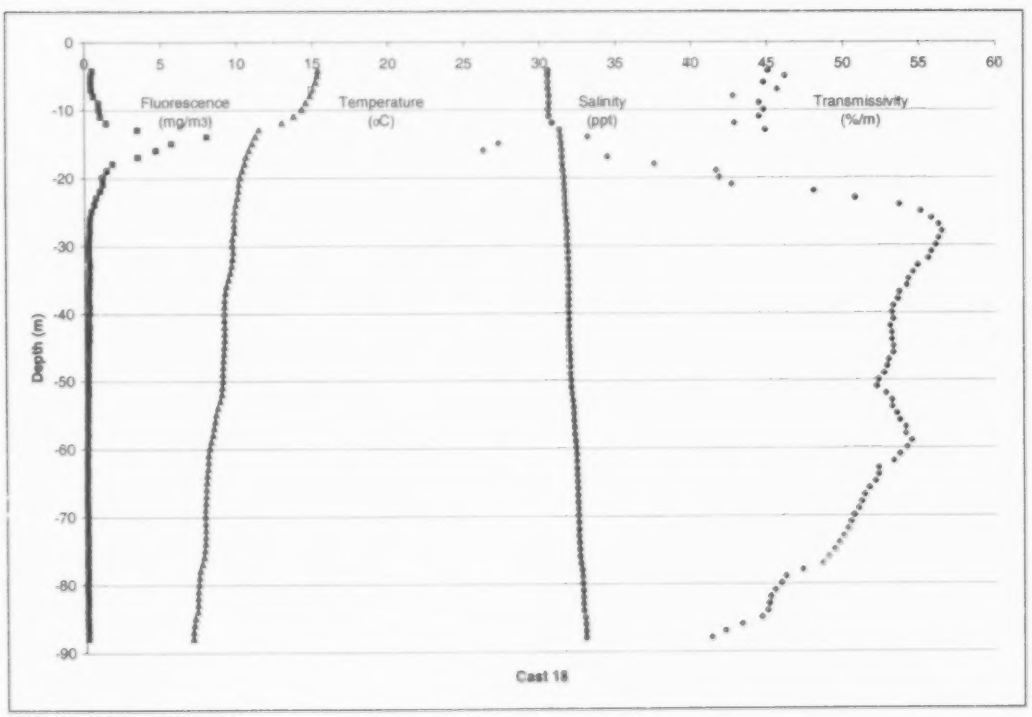

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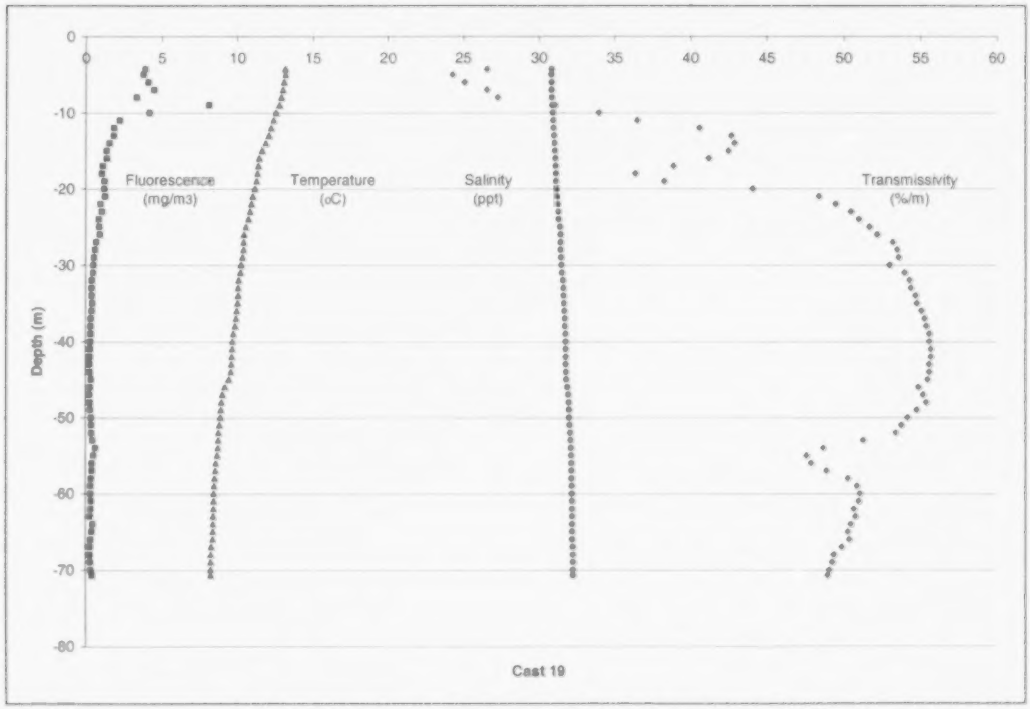

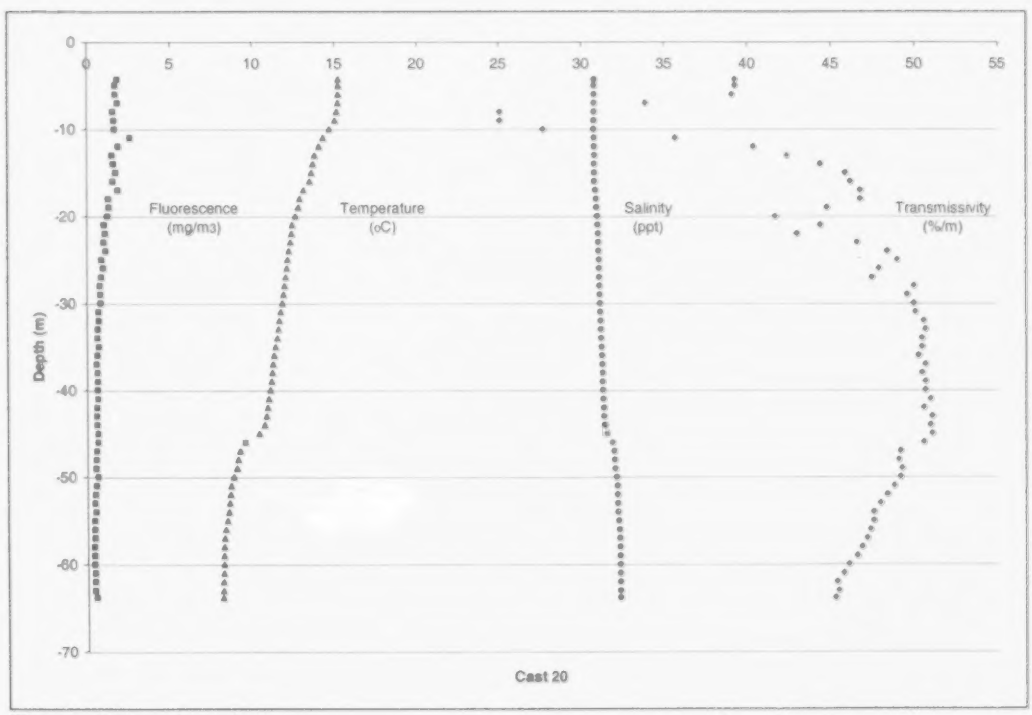

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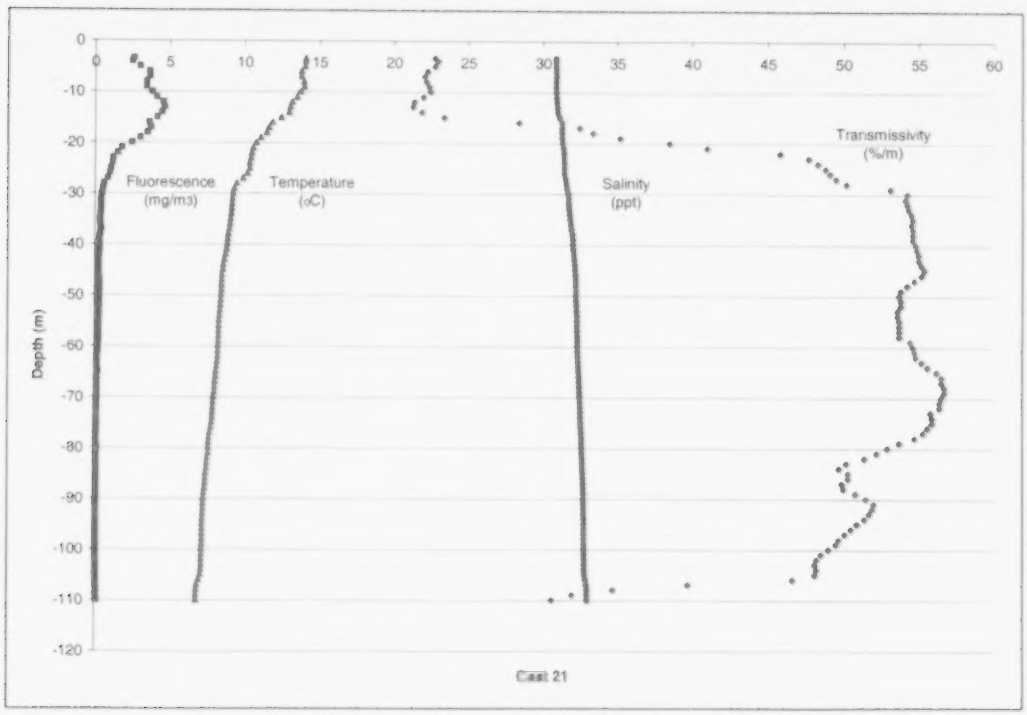

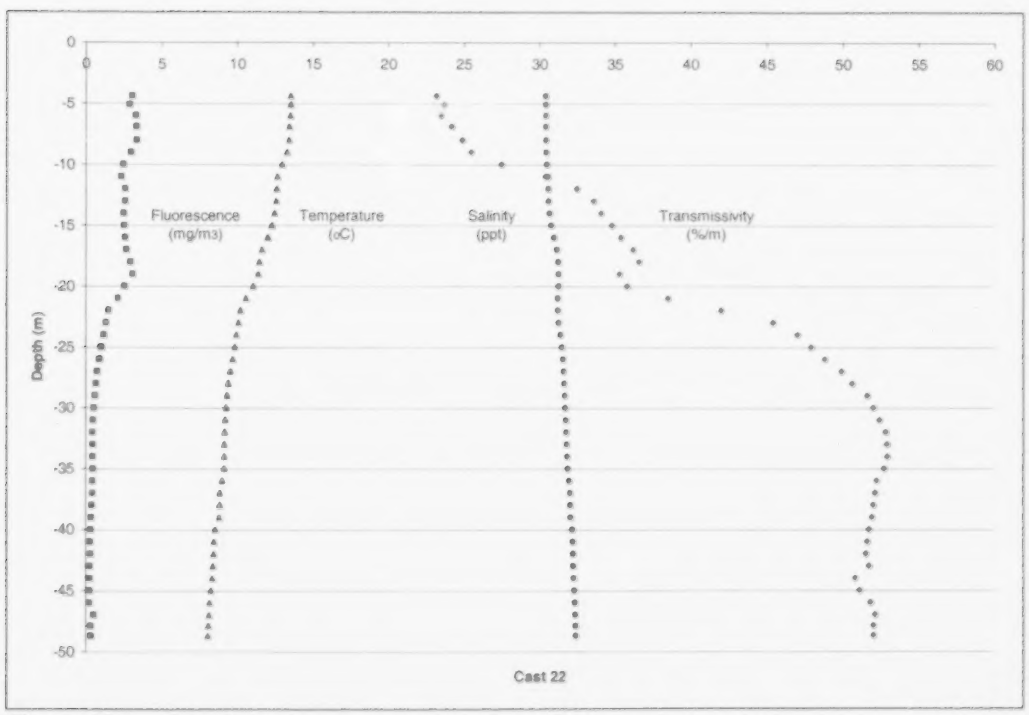

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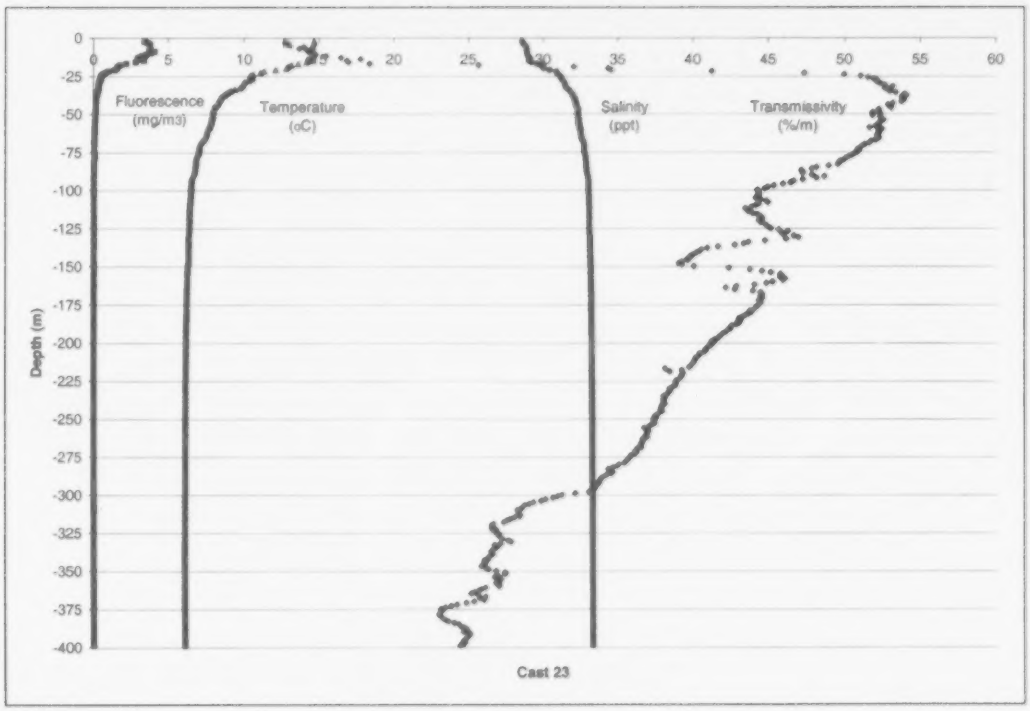

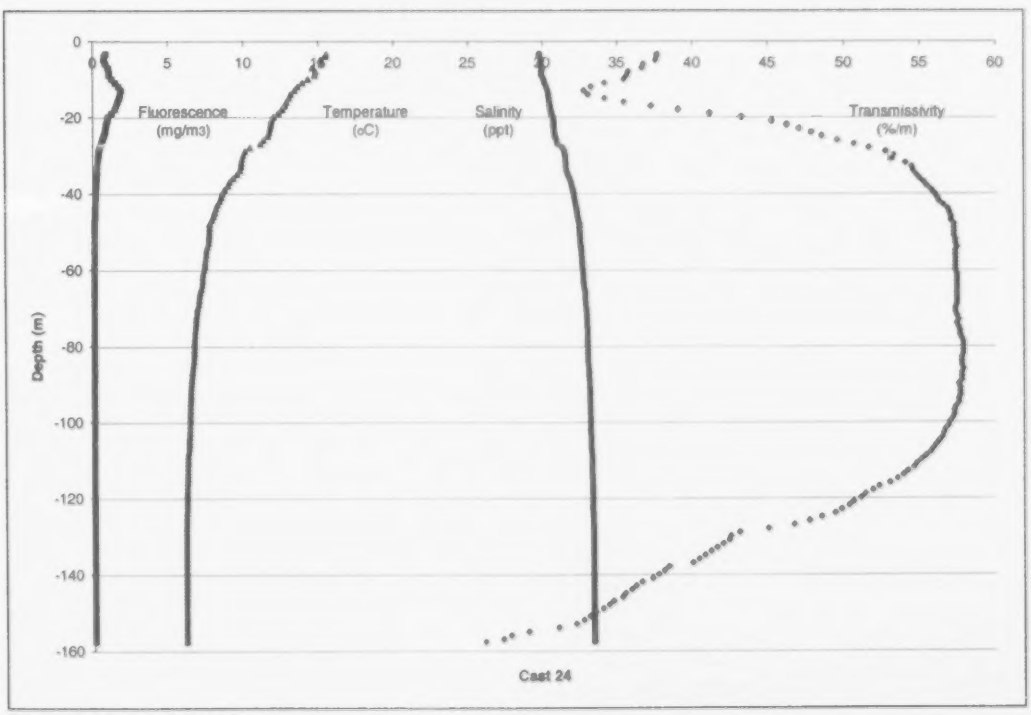

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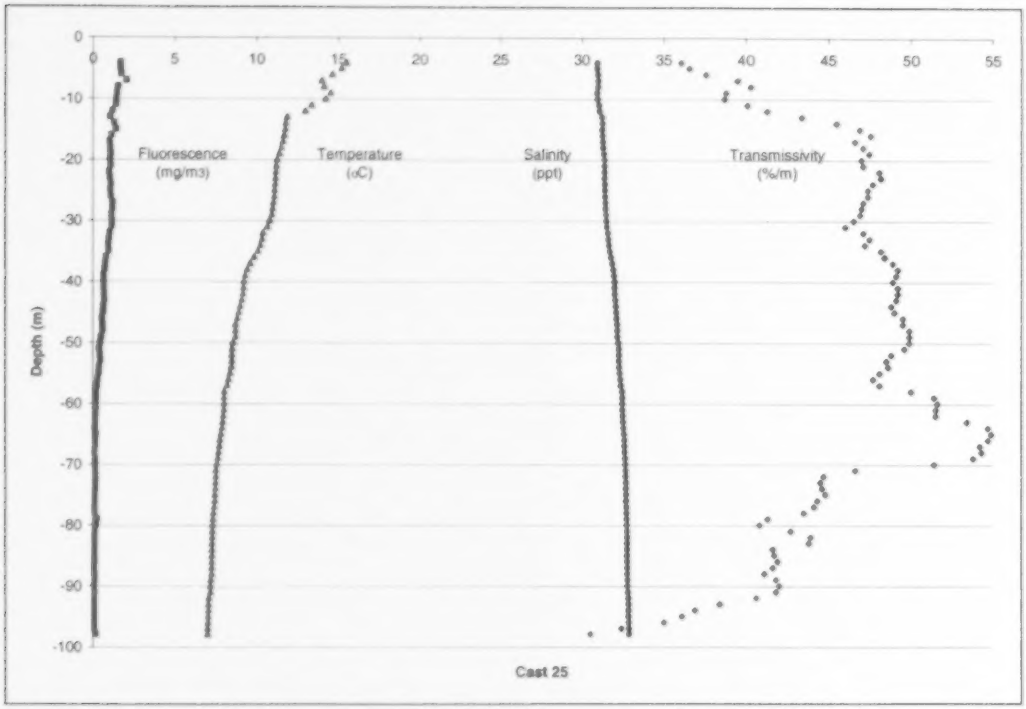

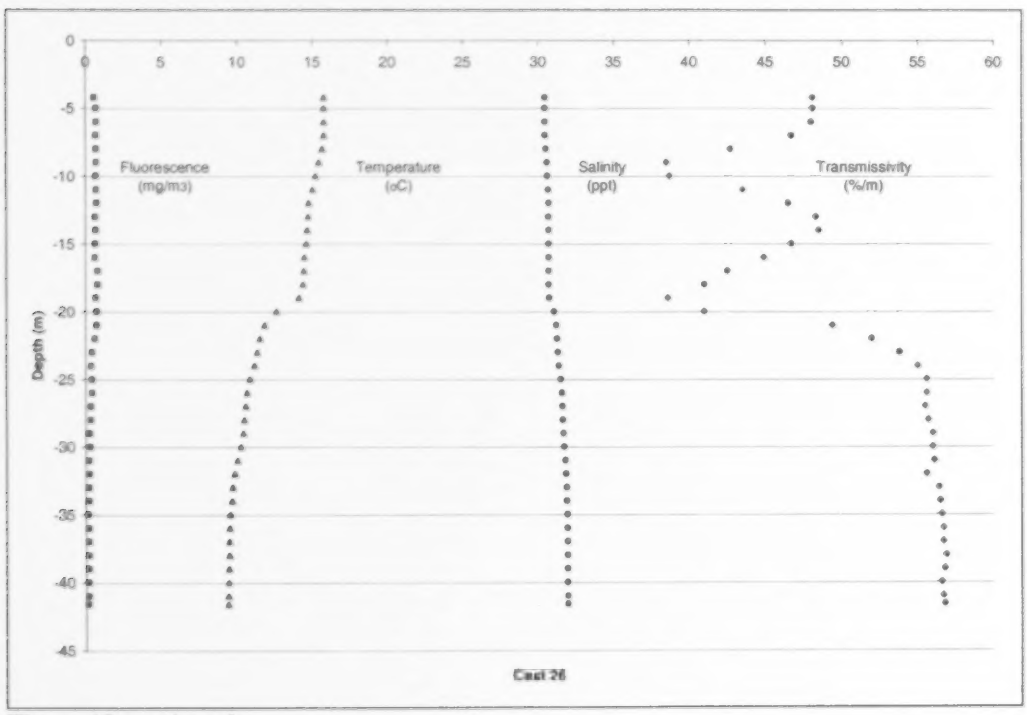

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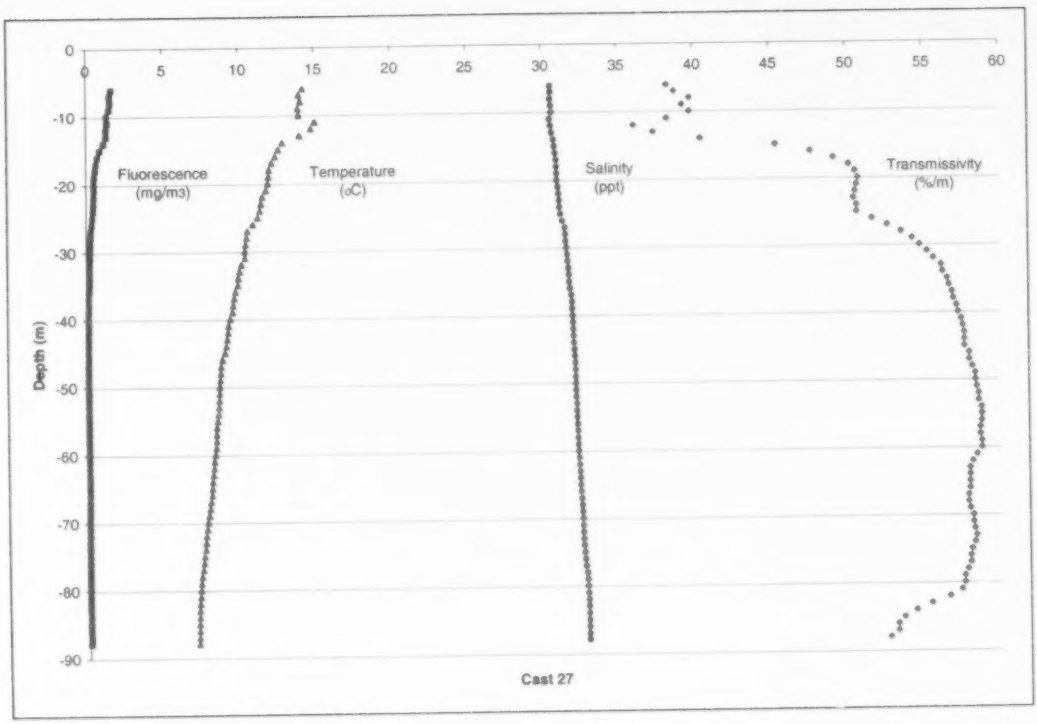

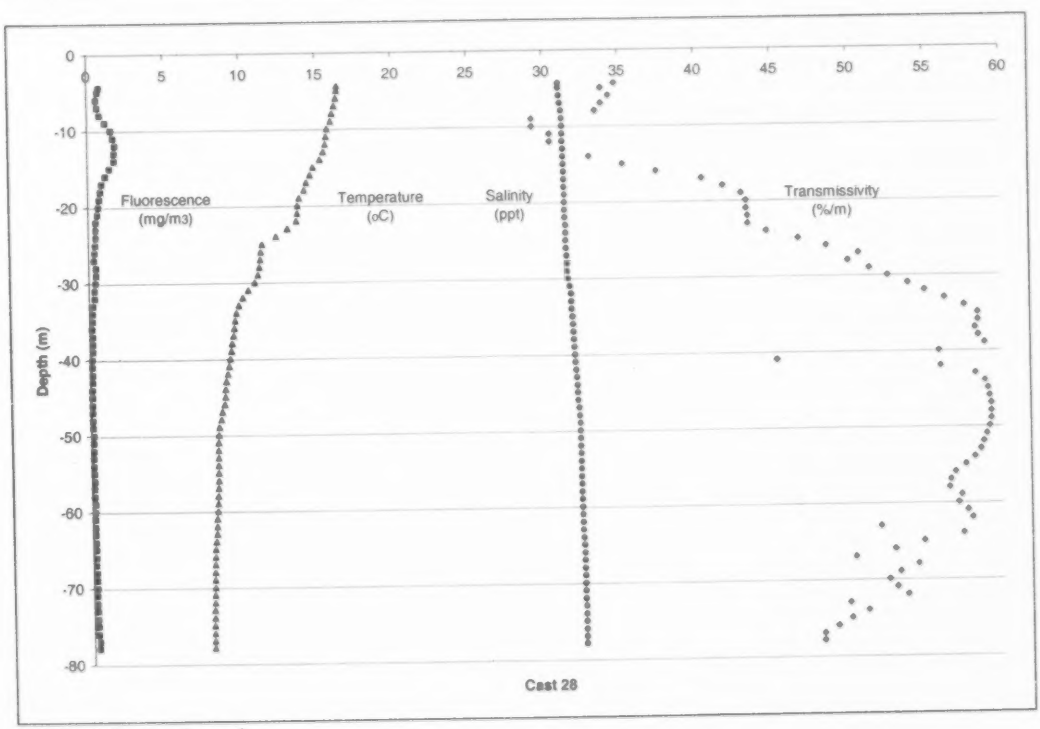

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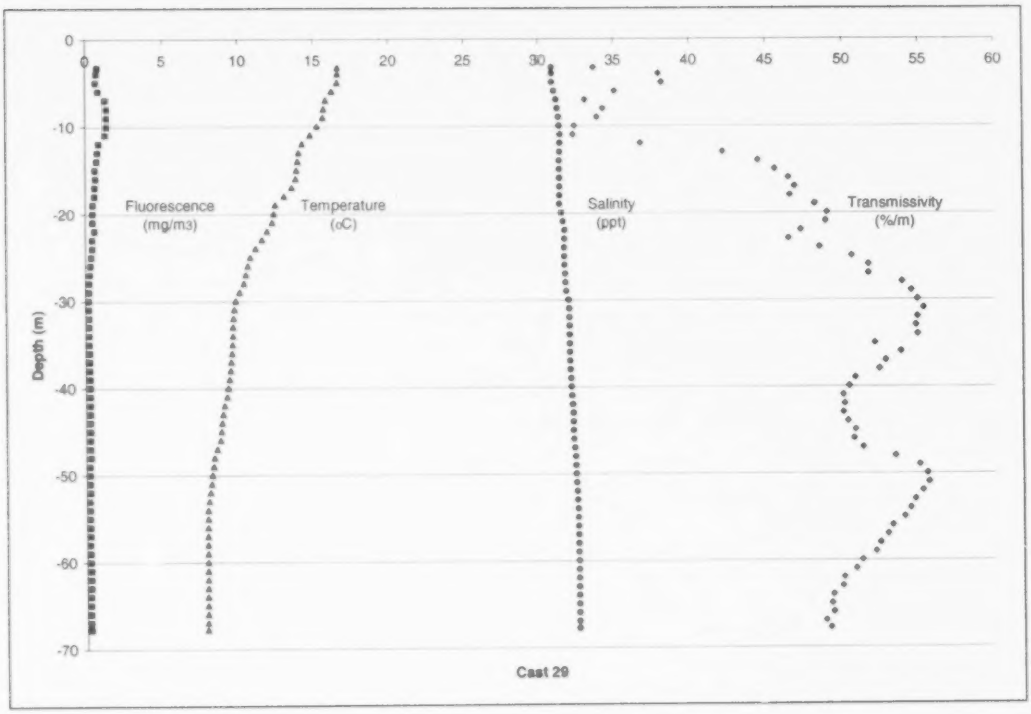

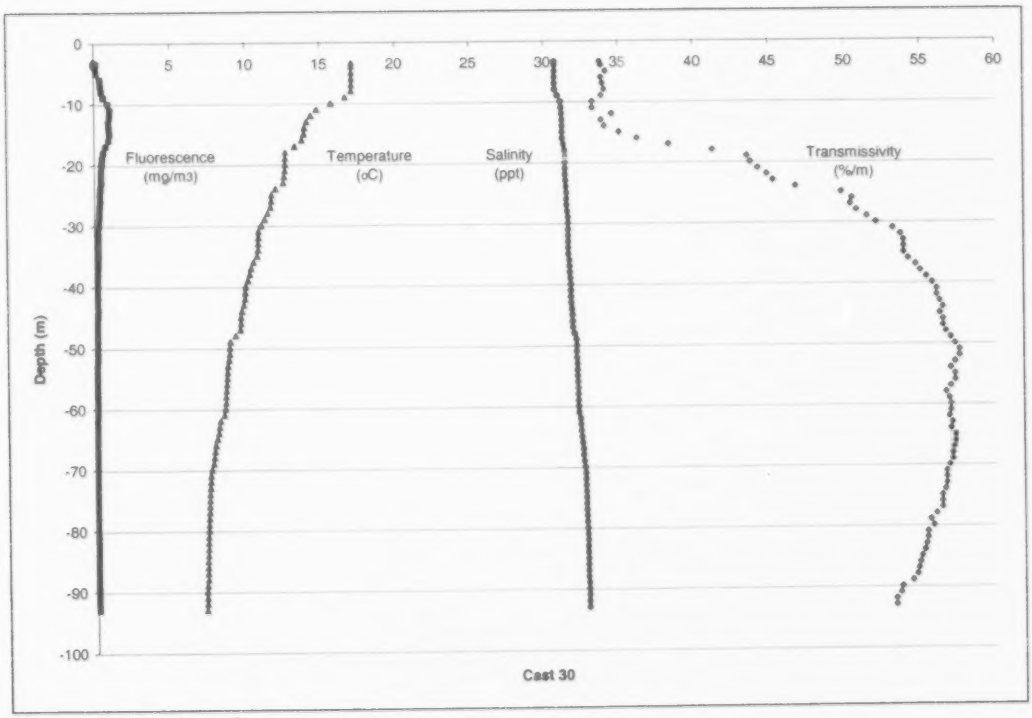

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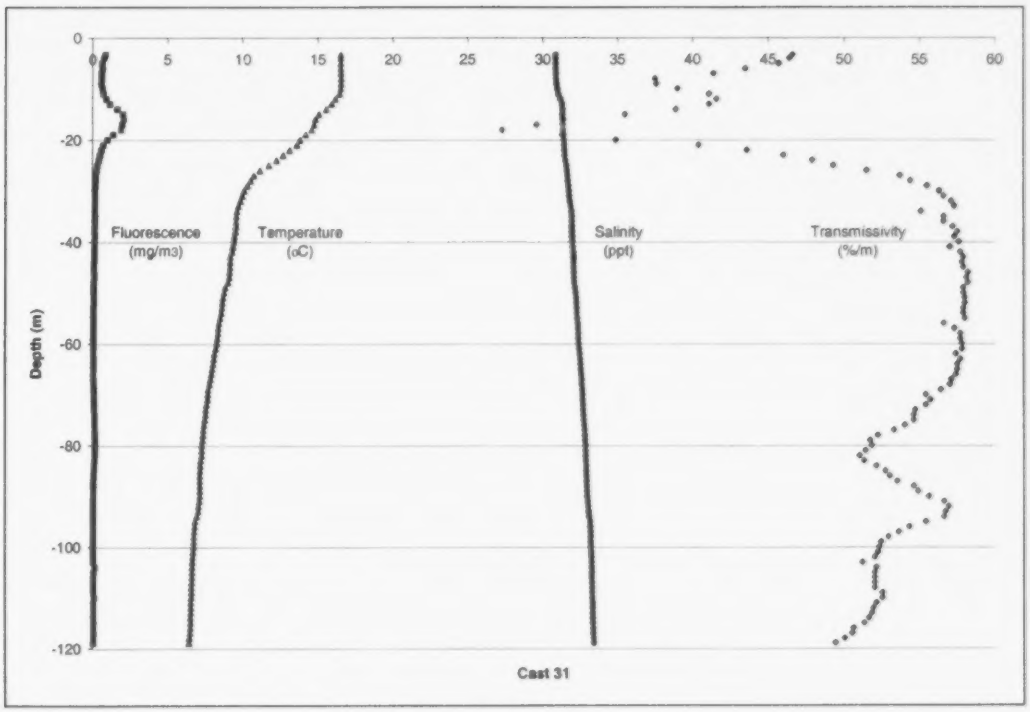

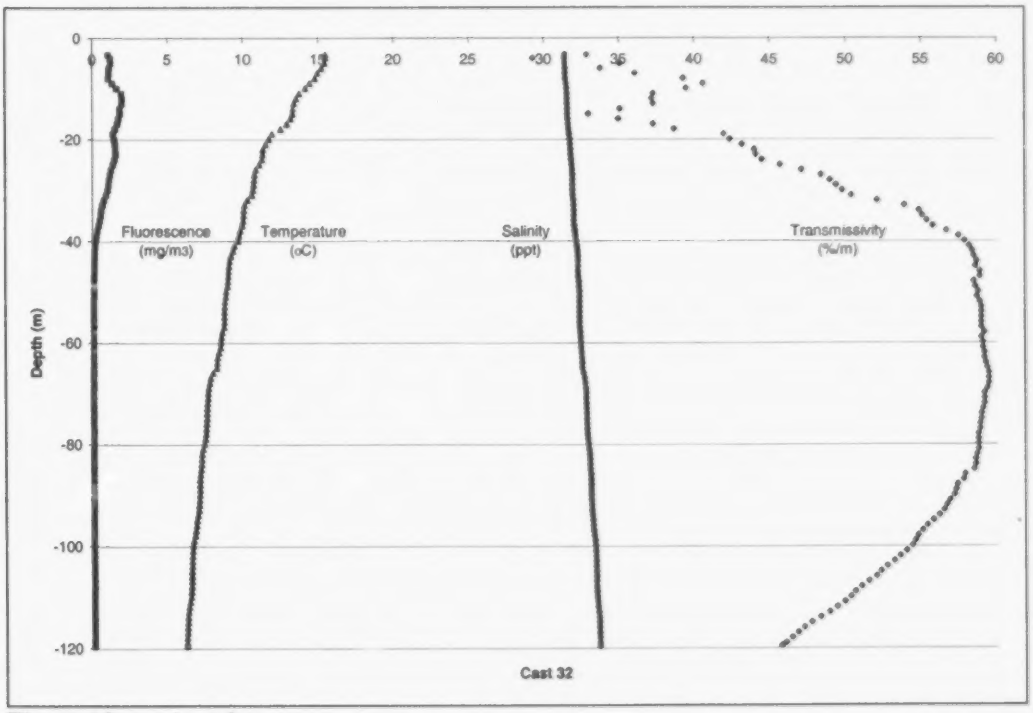

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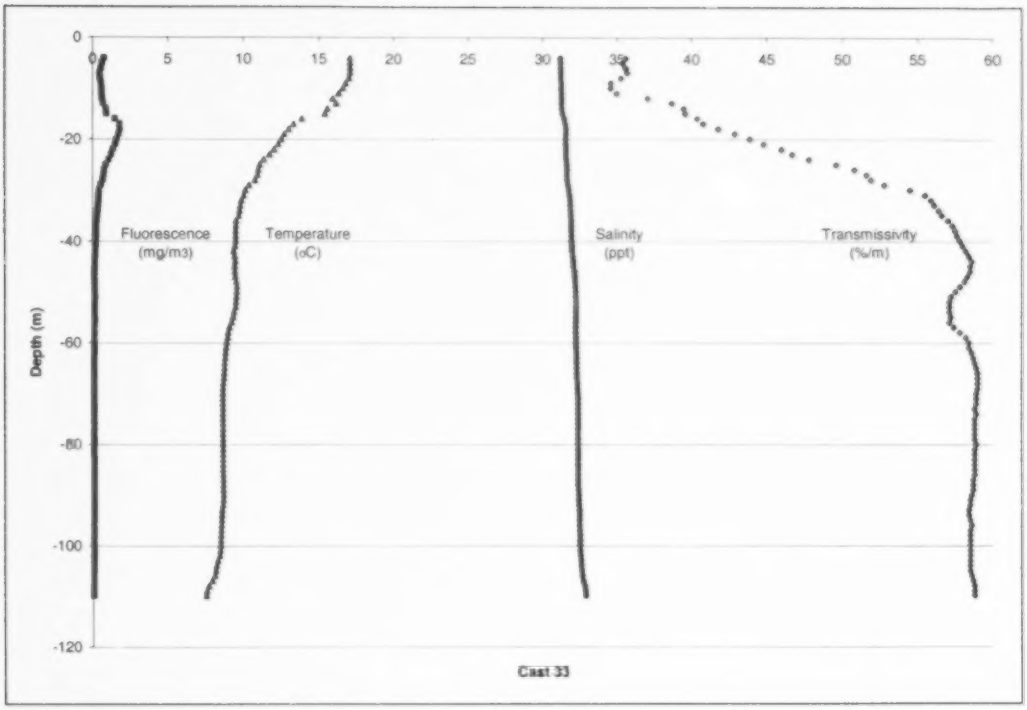

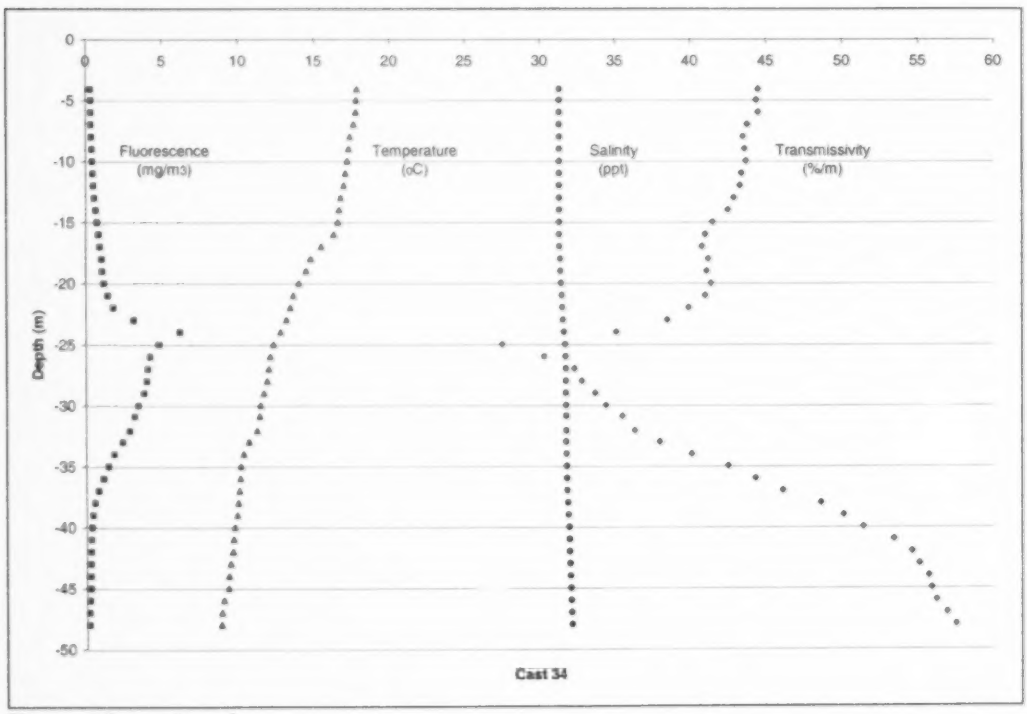

Figure 10 continued…

Table 1. Details of all mid-water trawl locations and times.

Set	Year	Month	Day	StartTime	Duration	EndTime	Start Lat N°	Start Long W°	End Lat N°	End Long W°
1	2004	8	4	909	5	916	51.4409	129.0823	51.4374	129.0938
2	2004	8	4	1404	10	1414	51.7518	129.3750	51.7504	129.3495
3	2004	8	5	1053	15	1108	53.2550	132.8023	53.2441	132.7931
4	2004	8	6	1754	4	1758	54.2551	132.6440	54.2576	132.6444
5	2004	8	7	719	16	735	54.1832	132.4509	54.1951	132.4603
6	2004	8	7	1121	7	1128	54.1533	132.0932	-	-
7	2004	8	7	1251	14	1305	54.1681	132.0211	54.1703	132.0465
8	2004	8	7	1839	4	1843	54.3014	131.3388	54.3178	131.3440
9	2004	8	8	933	17	950	53.0998	130.1790	53.0836	130.1783
10	2004	8	8	1243	15	1258	53.2268	130.4982	53.2276	130.4644
11	2004	8	9	1024	15	1039	53.7869	130.9179	53.7751	130.9072
12	2004	8	9	1254	19	1313	53.8288	130.9378	53.8451	130.9496
13	2004	8	9	1436	4	1440	53.8596	130.8156	53.8572	130.8158
14	2004	8	9	1808	17	1825	53.9962	131.0840	53.9788	131.0809
15	2004	8	10	728	7	735	54.0571	131.0766	54.0642	131.0763
16	2004	8	10	1206	20	1226	54.3190	131.1156	54.3019	131.0930
17	2004	8	10	1330	10	1340	54.3318	131.0566	54.2569	131.0591
18	2004	8	10	1620	12	1632	54.3926	131.0332	54.3788	131.0335
19	2004	8	11	923	19	942	54.4884	131.2847	54.4881	131.3108
20	2004	8	11	1311	8	1319	54.3999	131.2884	54.3950	131.2953
21	2004	8	11	1543	24	1607	54.3614	131.1430	54.3809	131.1634
22	2004	8	11	1825	13	1838	54.2026	131.0724	54.1895	131.0685
23	2004	8	12	738	15	753	53.4533	130.9564	53.4414	130.9490
24	2004	8	12	1126	8	1134	53.3229	130.9237	53.3234	130.9364
25	2004	8	12	1550	17	1607	53.1368	130.9117	53.1484	130.9254
26	2004	8	13	920	9	929	52.9690	130.6521	52.9636	130.6427
27	2004	8	15	734	10	744	51.7813	129.3606	51.7791	129.3484
28	2004	8	15	850	10	900	51.7608	129.4548	51.7671	129.4420
29	2004	8	15	1004	15	1019	51.7563	129.5557	51.7488	129.5695

Table 1 continued…

Set	Year	Month	Day	StartTime	Duration	EndTime	Start Lat N°	Start Long W°	End Lat N°	End Long W°
30	2004	8	15	1331	10	1341	51.4363	129.2166	51.4317	129.2034
31	2004	8	15	1400	7	1407	51.4295	129.1958	51.4311	129.2077

Table 2. Total number of herring scales, DNA, stomach and length samples taken from all sets.

Set	Scales	DNA	Stomach	Lengths
1	100	100	-	200
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	1
6	-	-	-	-
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
10	-	-	-	-
11	100	100	-	200
12	-	-	-	200
13	25	-	-	235
14	-	-	-	200
15	100	-	50	200
16	-	-	-	200
17	100	-	50	200
18	-	-	-	40
19	-	-	-	-
20	-	-	-	-
21	100	-	-	278
22	18	-	-	218
23	100	-	100	200
24	-	-	-	200
25	-	-	-	200
26	100	-	-	200
27	-	-	-	-
28	100	-	50	200
29	-	-	-	-
30	-	-	-	-
31	-	-	-	175
Totals	**843**	**200**	**250**	**3347**

Table 3. Detailed catch information by set.

Set	Year	Month	Day	Species	Weight (kg)	Total Catch (kg)	% of Total Catch	Notes
1	2004	8	4	**herring**	147.58	147.58	100.00	
2	2004	8	4	-	-	-	-	Water tow
3	2004	8	5	-	-	-	-	Small tow - not quantified
4	2004	8	6	hake	1422.98	1429.46	99.55	
				lamprey	0.04		0.00	
				yellowtail rockfish	2.72		0.19	
				silvergrey rockfish	3.72		0.26	
5	2004	8	7	**herring**	0.01			1 Herring and some jellyfish
6	2004	8	7	coho salmon	0.88	0.88	100.00	
7	2004	8	7	chum salmon	4.26	30.20	14.11	
				pink salmon	2.02		6.69	
				chinook salmon	20.78		68.81	
				coho salmon	3.10		10.26	
				pollock	0.04		0.13	
8	2004	8	7	hake	769.74	1174.34	65.55	
				pollock	67.64		5.76	
				eulachon	13.00		1.11	
				chinook salmon	3.24		0.28	
				yellowtail rockfish	320.72		27.31	
9	2004	8	8	hake	148.44	167.73	88.50	
				yellowtail rockfish	6.12		3.65	
				silvergrey rockfish	12.46		7.43	
				pollock	0.64		0.38	
				sandlance	0.07		0.04	
10	2004	8	8	pollock	0.06	1.42	4.23	
				prowfish	0.16		11.27	
				chinook salmon	1.20		84.51	

Table 3 continued...

Set	Year	Month	Day	Species	Weight (kg)	Total Catch (kg)	% of Total Catch	Notes
11	2004	8	9	**herring**	900.86	907.36	99.28	
				arrowtooth flounder	1.70		0.19	
				chinook salmon	4.80		0.53	
12	2004	8	9	**herring**	530.44	543.48	97.60	
				chinook salmon	5.74		1.06	
				arrowtooth flounder	2.76		0.51	
				Pacific cod	4.52		0.83	
				sandfish	0.024		0.00	
13	2004	8	9	**herring**	3985.92	4000.00	99.65	
				sablefish	0.70		0.02	
				chinook salmon	8.76		0.22	
				coho salmon	4.62		0.12	
14	2004	8	9	**herring**	1212.34	1212.65	99.97	
				chinook salmon	0.293		0.02	
				sandfish	0.017		0.00	
15	2004	8	10	**herring**	314.82	314.85	99.99	
				prowfish	0.018		0.01	
				sandfish	0.006		0.00	
				pollock	0.004		0.00	
				sandlance	0.005		0.00	
16	2004	8	10	**herring**	302.66	321.12	94.25	
				coho salmon	7.80		2.43	
				chinook salmon	5.08		1.58	
				arrowtooth flounder	5.22		1.63	
				sandlance	0.02		0.00	
				sandfish	0.35		0.11	

Table 3 continued...

Set	Year	Month	Day	Species	Weight (kg)	Total Catch (kg)	% of Total Catch	Notes
17	2004	8	10	**herring**	369.14	380.92	96.91	
				chinook salmon	9.00		2.36	
				Pacific cod	2.60		0.68	
				sandfish	0.12		0.03	
				squid	0.01		0.00	
				eulachon	0.05		0.01	
18	2004	8	10	**herring**	4.24	4.24	100.00	
19	2004	8	11	eulachon	4.34	14.60	29.73	
				hake	1.86		12.74	
				chinook salmon	5.66		38.78	
				arrowtooth flounder	1.58		10.82	
				Pacific lamprey	0.06		0.39	
				pollock	5.44		37.27	
20	2004	8	11	hake	649.52	846.72	76.71	
				arrowtooth flounder	4.66		0.55	
				pollock	162.98		19.25	
				eulachon	29.56		3.49	
21	2004	8	11	**herring**	94.92	123.81	76.67	
				sandfish	0.50		0.40	
				sandlance	0.01		0.00	
				chinook salmon	16.74		13.52	
				arrowtooth flounder	11.64		9.40	
22	2004	8	11	**herring**	98.04	101.06	97.01	
				Pacific cod	0.88		0.87	
				chinook salmon	1.82		1.80	
				sandfish	0.30		0.30	
				sandlance	0.02		0.02	

Table 3 continued…

Set	Year	Month	Day	Species	Weight (kg)	Total Catch (kg)	% of Total Catch	Notes
23	2004	8	12	**herring**	460.52	495.37	92.96	
				arrowtooth flounder	12.80		2.58	
				sandfish	0.01		0.00	
				pollock	0.04		0.01	
				yellowtail rockfish	3.20		0.65	
				sharpchin rockfish	13.46		2.72	
				Pacific cod	5.34		1.08	
24	2004	8	12	**herring**	584.00	598.74	97.54	
				arrowtooth flounder	14.60		2.44	
				pollock	0.14		0.02	
				sandlance	trace		0.00	
25	2004	8	12	**herring**	112.80	112.86	99.95	
				sandlance	0.04		0.04	
				prowfish	0.02		0.01	
26	2004	8	13	**herring**	347.58	347.61	99.99	
				pollock	0.03		0.01	
				sandlance	trace		0.00	
27	2004	8	15	-	-	-	-	Small tow - not quantified
28	2004	8	15	**herring**	661.68	661.68	100.00	
29	2004	8	15	hake	37.62	40.26	93.44	
				lanternfish	0.46		1.14	
				poacher	trace		0.00	
				sharpchin rockfish	2.18		5.41	
				juvenile rockfish	trace		0.00	
30	2004	8	15	-	-	-	-	problem with net
31	2004	8	15	**herring**	3998.51	4000.00	99.96	
				sandlance	0.01		0.00	
				sharpchin Rockfish	1.48		0.04	

Table 4. Mean length (mm), weight (g) and percent composition of all aged herring.

Set		Age 0	1	2	3	4	5	6	7	8	9	10	11
1	Mean Length	-	140.4	170.2	177.9	196.7	-	-	-	-	-	-	-
	Mean Weight	-	31.00	54.07	65.71	77.33	-	-	-	-	-	-	-
	% Composition	-	5.56	83.33	7.78	3.33	-	-	-	-	-	-	-
11	Mean Length	-	137.9	152.8	141.3	173.7	165.0	180.0	-	-	-	-	-
	Mean Weight	-	34.00	47.38	38.75	75.92	59.00	75.60	-	-	-	-	-
	% Composition	-	16.13	60.22	4.30	12.90	1.08	5.38	-	-	-	-	-
13	Mean Length	-	-	-	-	-	248.0	252.0	259.5	268.0	258.7	257.3	-
	Mean Weight	-	-	-	-	-	186.00	195.00	213.00	240.00	205.33	220.00	-
	% Composition	-	-	-	-	-	9.09	4.55	27.27	31.82	13.64	13.64	-
15	Mean Length	114.0	125.9	150.0	149.0	158.4	172.0	167.0	169.0	174.7	-	212.0	-
	Mean Weight	17.00	25.04	45.48	43.83	52.57	75.00	67.00	63.00	74.67	-	134.00	-
	% Composition	1.10	51.65	29.67	6.59	7.69	1.10	1.10	1.10	3.30	-	2.20	-
17	Mean Length	-	-	158.9	166.0	190.7	200.1	191.3	177.5	-	181.5	-	-
	Mean Weight	-	-	54.17	59.50	95.27	105.07	94.25	71.75	-	70.50	-	-
	% Composition	-	-	13.19	2.20	48.35	16.48	13.19	4.40	-	2.20	-	-
21	Mean Length	-	132.5	167.8	182.7	194.1	188.9	188.2	192.4	190.6	-	-	-
	Mean Weight	-	25.50	53.41	66.33	85.93	77.83	77.77	80.60	78.88	-	-	-
	% Composition	-	2.08	17.71	6.25	29.17	12.50	13.54	10.42	8.33	-	-	-
22	Mean Length	-	-	-	-	208.0	235.0	236.5	251.3	-	251.0	257.0	258.0
	Mean Weight	-	-	-	-	100.00	160.00	166.50	195.00	-	193.67	209.00	235.50
	% Composition	-	-	-	-	5.88	11.76	23.53	23.53	-	17.65	5.88	11.76
23	Mean Length	-	140.7	171.9	195.8	201.0	213.4	220.0	196.0	256.0	-	-	-
	Mean Weight	-	32.33	62.04	90.00	98.84	108.33	132.80	87.00	194.50	-	-	-
	% Composition	-	3.16	25.26	5.26	47.37	9.47	5.26	2.11	2.11	-	-	-
26	Mean Length	-	-	177.8	187.7	203.1	206.3	219.7	-	241.0	229.0	-	-
	Mean Weight	-	-	66.04	81.14	101.32	104.67	132.67	-	159.00	149.00	-	-
	% Composition	-	-	53.26	7.61	27.17	6.52	3.26	-	1.09	1.09	-	-

Table 4 continued...

Set		Age 0	1	2	3	4	5	6	7	8	9	10	11
28	Mean Length	-	-	181.2	203.0	208.8	208.6	217.0	214.3	-	-	-	-
	Mean Weight	-	-	73.40	106.10	114.30	115.22	133.50	122.67	-	-	-	-
	% Composition	-	-	5.32	21.28	56.38	9.57	4.26	3.19	-	-	-	-
Total Mean length		114.0	130.2	165.6	183.9	197.3	203.7	200.7	213.3	222.8	235.7	242.2	258.0
Total Mean weight		17.00	27.64	55.04	79.56	97.47	104.84	105.08	125.20	146.81	165.22	189.50	235.50
Total % Composition		0.13	9.16	33.72	7.25	27.74	7.25	6.11	3.82	2.67	1.15	0.76	0.25